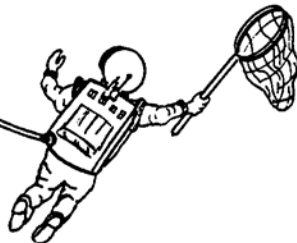
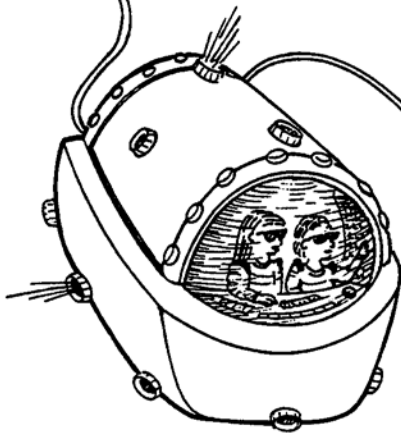


Our Solar System



OUR SOLAR SYSTEM SERIES

OUR SOLAR SYSTEM, video, grades K–3

OUR SOLAR SYSTEM, booklet, grades K–3

NUESTRO SISTEMA SOLAR, booklet, grades K–3

OUR SOLAR SYSTEM, booklet, grades 2–5

NUESTRO SISTEMA SOLAR, booklet, grades 2–5

OUR SOLAR SYSTEM, TEACHER'S GUIDE AND
ACTIVITIES

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Translators: Thea Cañizo and Graciela Manjarre

Illustrator: Karen Swarthout

OUR SOLAR SYSTEM

The sun is the center of our solar system. It is the largest body in our solar system. Nine planets follow paths called **orbits** around the sun. The shape of each orbit is called an **ellipse**. An ellipse is a flattened circle (see the picture at the bottom of page 3). The nine planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.

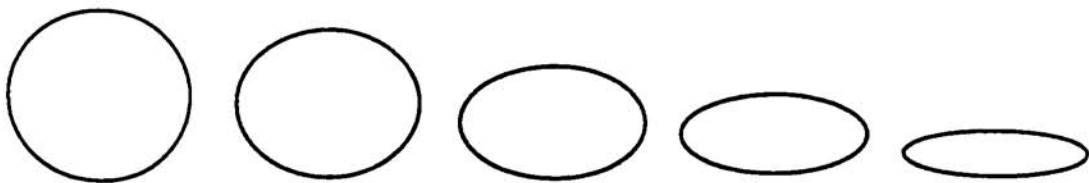
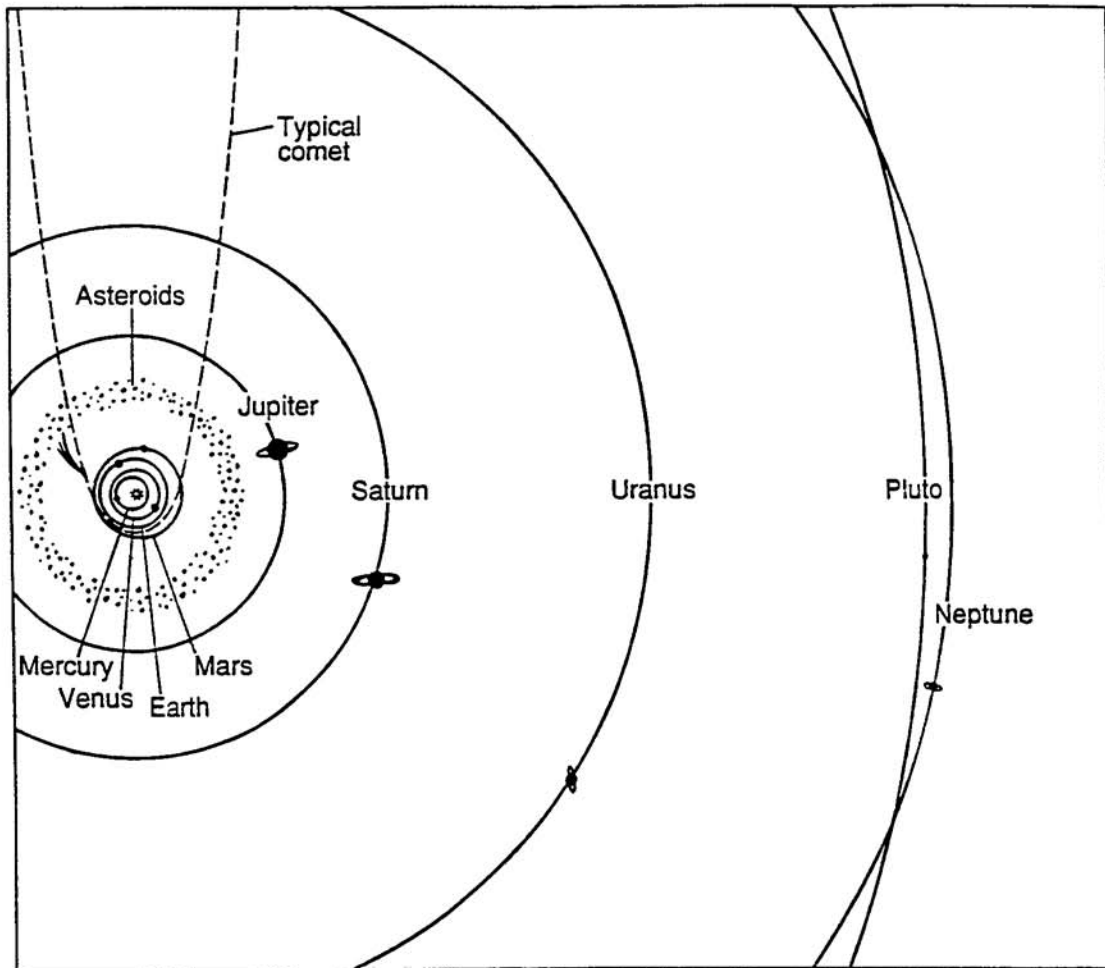
Moons, asteroids, comets, and meteoroids are also part of our solar system. Moons orbit planets. Asteroids, comets and meteoroids orbit the sun. You will learn about these objects as you read *Our Solar System*. The sun is the only object in our solar system to shine with its own light. All other objects in our solar system reflect the light of the sun.

Scientists have studied our solar system from telescopes on Earth and from telescopes in orbit around Earth. Astronauts have visited the moon. Spacecraft have been sent to study almost all of the planets in the solar system.

Giant dust storms, freezing temperatures, colorful clouds, and beautiful rings can be found throughout the solar system.

Science Words: As you read *Our Solar System* look for words in **bold print**. The meanings of these words can be found in the Glossary on page 37.

Our Solar System



Although these shapes do not look exactly alike, they are all ellipses.

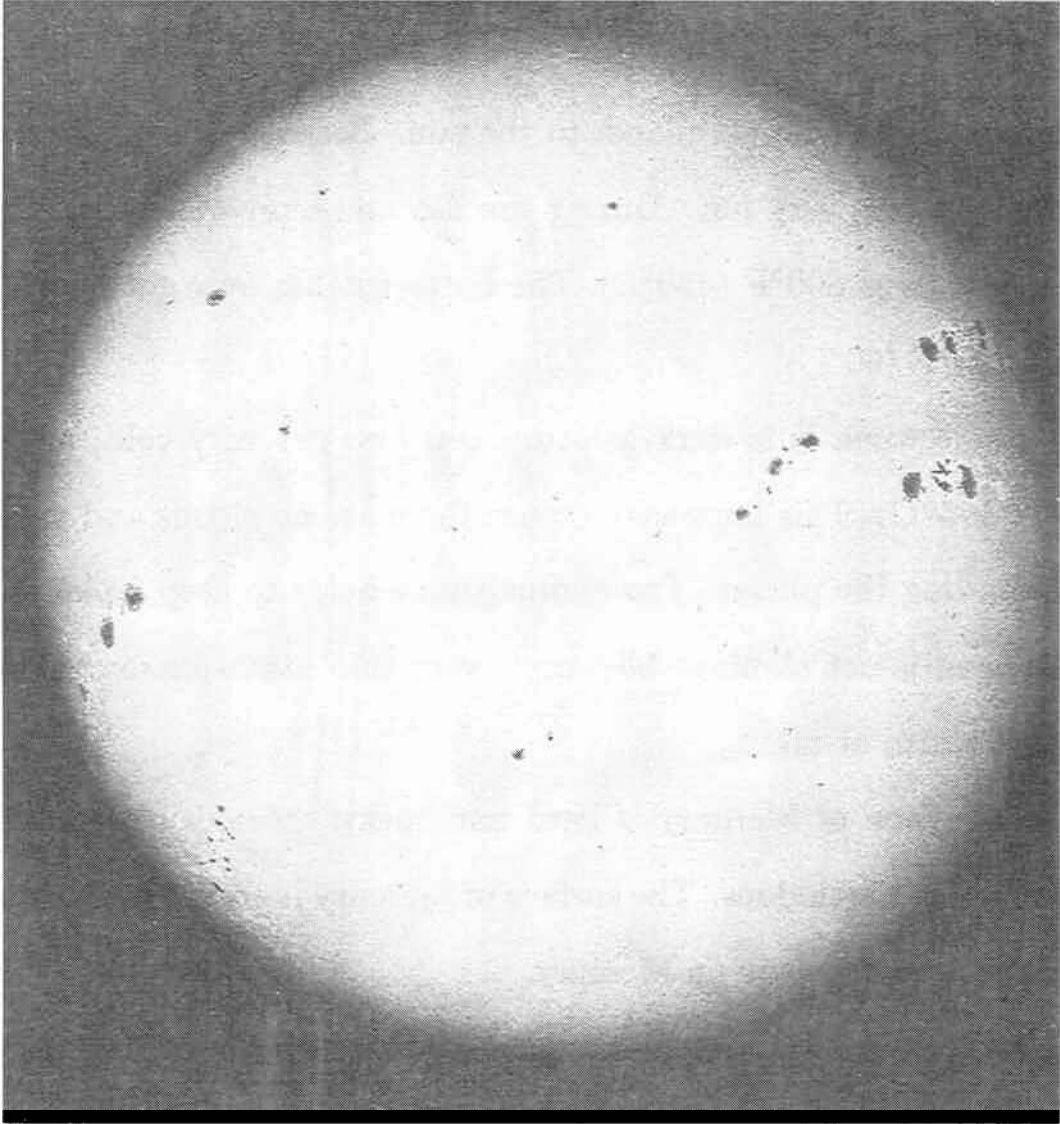
The orbits of the planets. Look carefully at the orbits of Neptune and Pluto. Trace the orbit of Pluto with your finger. Find two places where the orbit of Pluto crosses the orbit of Neptune.

THE SUN

The **sun** is a ball of hot, glowing **gases**. It is much hotter than any of the nine **planets**. The outermost layer of the sun that we can see is about 10,000°F (5,600°C). The hottest the oven in your kitchen gets is about 500°F (260°C)! The sun is the most important part of our **solar system**. It gives us warmth and light. Without the sun, our Earth would be very cold. If there were no sun, there would be no life on Earth.

The sun is a **star**. It is the closest star to Earth. At night we can see many stars in the dark sky. During the day when we can see our star (the sun) shining, its light is so bright we cannot see the other stars. Some stars are hotter than our sun, others are cooler. Some stars are bigger than our sun and other stars are smaller, but they are so far away from Earth that they look like tiny points of light. Our sun is 10 times larger than the largest planet, Jupiter.

Challenge: How would Earth be different if our sun were replaced by a much hotter star or a much cooler star?



Sun. Our sun is the closest star to Earth. It gives us warmth and light.

MERCURY

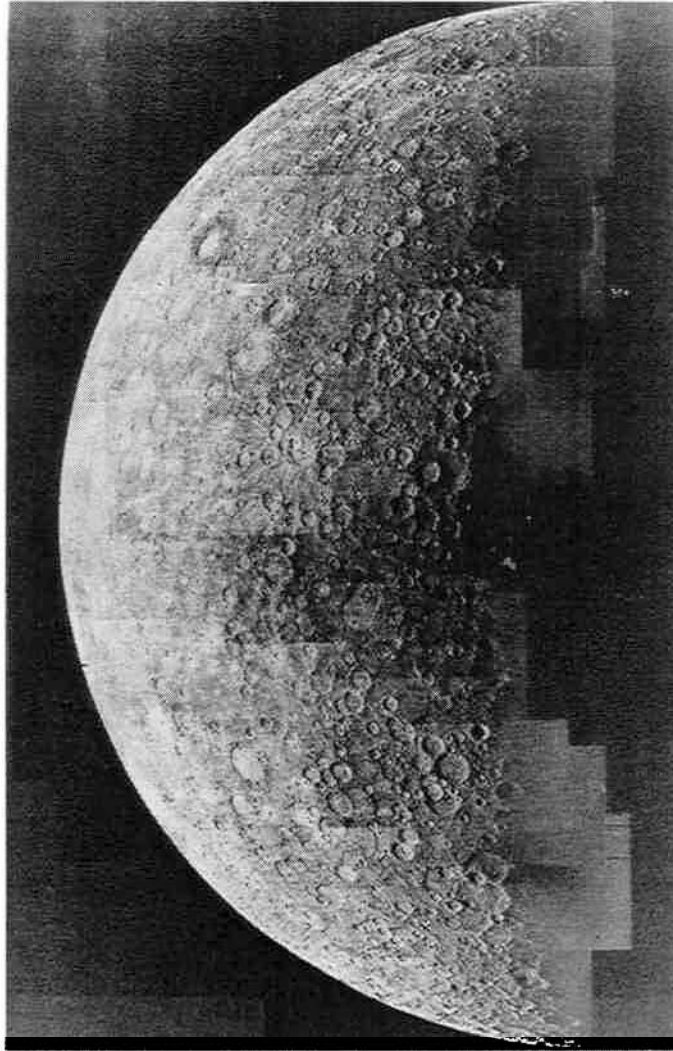
Mercury is the closest planet to the sun. Because it is so close to the sun, Mercury gets very hot. During the day the temperature on Mercury can get as high as 800°F (430°C). The hottest it has ever gotten on Earth is about 135°F (60°C)!

At night when it is dark Mercury can also get very cold, as cold as -280°F (-175°C). This happens because there are no clouds and very little air surrounding the planet. The **atmosphere** helps to keep a planet warm when the sun is not shining. Mercury's very thin atmosphere cannot keep the planet warm at night.

The **surface** of Mercury is hard and rocky. Mercury has **cliffs** and **valleys** just as Earth does. The surface of Mercury is covered with **craters**. There is no liquid **water** on Mercury.

An American **spacecraft** flew past Mercury and took pictures of one half of this rocky, hot-and-cold planet.

Challenge: What do you think made the craters on Mercury?



Mercury. Its surface has craters, cliffs, and valleys. We have only seen about half of the surface of Mercury.

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
moons	0								
rings	no								

VENUS

Venus is the second planet from the sun. We can call Venus our neighbor because it is the closest planet to our Earth.

Venus is the hottest planet in the solar system, even though it is farther from the sun than Mercury. It can get as hot as 900°F (480°C) on Venus. The temperature can get this high because Venus has a thick atmosphere. The air around the planet is mostly a gas called **carbon dioxide**. The carbon dioxide traps the heat from the sun on the planet's surface. This is called the **greenhouse effect**. A greenhouse on Earth is designed to trap heat to help plants grow.

Venus is a very dry planet. It is covered by thick clouds. Earth's clouds contain water, but Venus' clouds contain **sulfuric acid**. These clouds are so thick that astronomers on Earth cannot see the surface of the planet with their telescopes.

Soviet spacecraft landed on Venus and sent back pictures of its surface. In 1990 the American spacecraft Magellan began orbiting Venus, using **radar** to "see" through the clouds. These radar pictures show craters, **mountains, volcanoes**, and valleys on the surface of Venus.

Challenge: What can we learn from a spacecraft that lands on a planet? What can we learn from a spacecraft that orbits a planet?



Venus. Venus is a cloud-covered planet. With radar we can see its mountains and valleys.

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
moons	0	0							
rings	no	no							

EARTH

The third planet from the sun is Earth, our home. Earth does not get as hot as Venus. The highest temperature ever recorded on Earth is about 135°F (60°C). The lowest recorded temperature is about -125°F (-85°C).

The surface of Earth is similar to the surfaces of Mercury and Venus. Earth is a hard, rocky planet. There are high mountains, valleys, volcanoes, and even some craters. Earth is different in some very important ways. Most of the planet is covered with water. Also, the air is made of **nitrogen**, **oxygen**, and carbon dioxide. It is just right for us to breathe! Earth is home to people, plants, and animals because it has both water and the right kind of atmosphere.

American astronauts took the first pictures of the whole Earth from a spacecraft traveling to our **moon** in 1968.

Challenge: Do you think there are plants and animals anywhere else in the solar system?



Earth. Earth is our home. It has air for us to breathe and is warm enough for us to live.

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
moons	0	0	1						
rings	no	no	no						

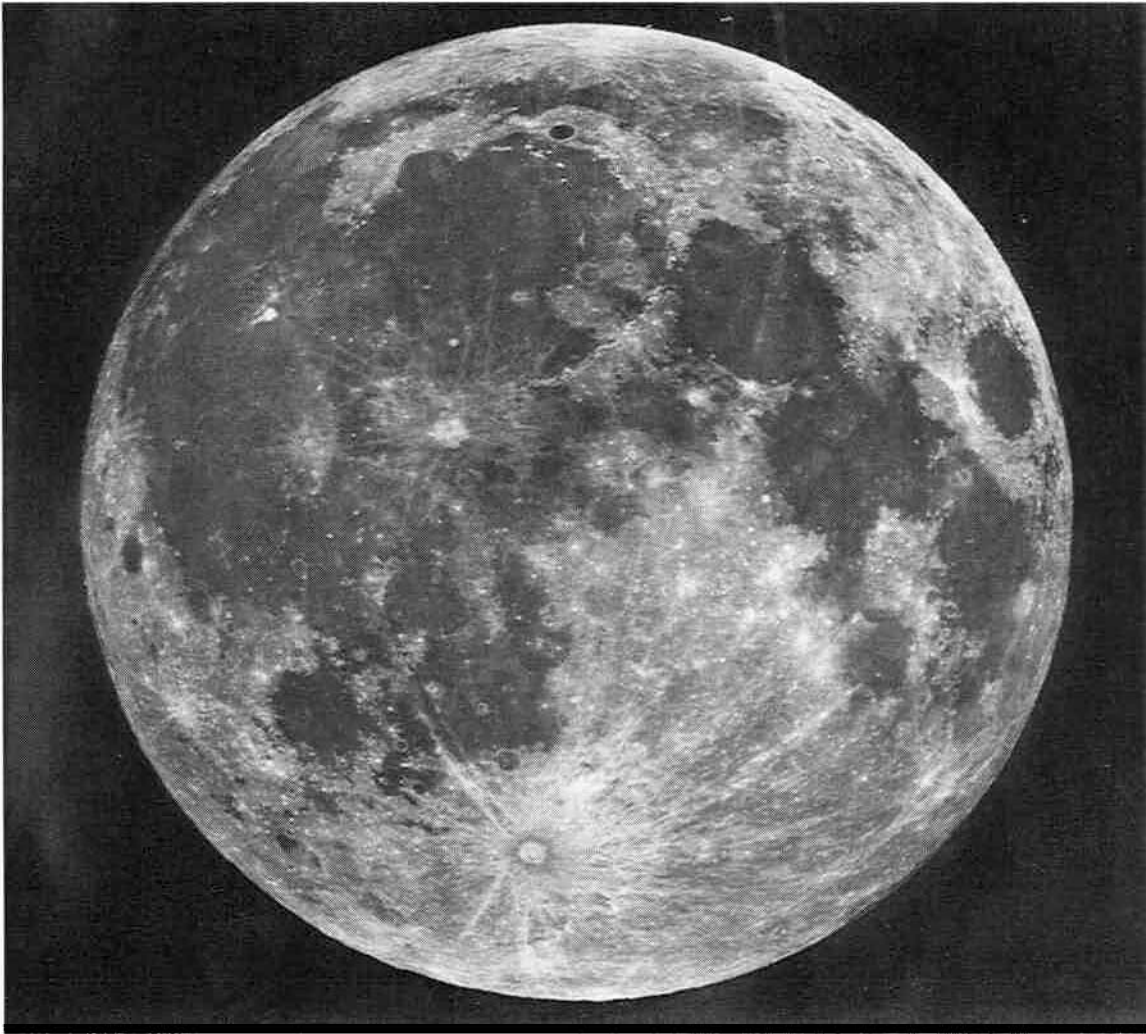
EARTH'S MOON

Earth has one moon. The moon is our nearest neighbor in the solar system. It follows a path or **orbit** around Earth, just as Earth follows a path around the sun.

Our moon has mountains and valleys. It is covered with craters. The surface of the moon is rocky and covered with dust. The moon's atmosphere is even thinner than Mercury's! The temperature on the moon can reach 265°F (130°C). Because there is almost no atmosphere, the temperature can drop to -170°F (-110°C) at night. There is no water on the moon. There is no life on the moon because it has no water and no air.

Twelve American astronauts walked on the moon between 1969 and 1972. They took pictures and collected **lunar** rocks and dirt. Scientists studied the rocks and dirt to learn more about the moon. They learned that the surface of the moon is much older than the surface of Earth.

Challenge: Find five books in the library with the word "moon" in the title. Choose one to read.



Earth's moon. Our moon has mountains and valleys. Does it look like any of the planets?

If you visited the moon, you would weigh much less than you do on Earth. Your lunar weight would equal about $1/6$ your Earth weight. Divide your earth weight by 6 to find your exact lunar weight, or use the chart below to find your approximate lunar weight:

Earth weight	Moon weight	Earth weight	Moon weight
114	19	66	11
108	18	60	10
102	17	54	9
96	16	48	8
90	15	42	7
84	14	36	6
78	13	30	5
72	12	24	4

MARS

Mars is the fourth planet from the sun. Mars can get very cold. The temperature can get as low as -200°F (-130°C). In a few places it can be a pleasant 80°F (30°C) during the day. In most places it never gets above freezing.

Mars is a hard, rocky planet. The soil on Mars contains iron oxide (rust), which makes the ground look red. This is why Mars is often called the red planet. Sometimes the red dirt is stirred up by strong winds. These huge dust storms can last for months. Mars has mountains, **canyons**, volcanoes, and craters. Scientists think that the large canyons were formed long ago by water. There is no liquid water on the surface of Mars now. There may be frozen water under the surface. There is ice on the surface at the coldest places. Mars has an atmosphere made almost entirely of carbon dioxide and traces of nitrogen and other gases. American and Soviet spacecraft were sent to Mars to study the planet. Two spacecraft landed on Mars. They studied the atmosphere and collected soil samples to look for signs of life, but no life was found. Orbiting spacecraft also studied the two small, rocky moons of Mars.

Challenge: If you were planning a trip to Mars, what would you take on your trip?



Mars. Mars has mountains, volcanoes, canyons, valleys, and craters.

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
moons	0	0	1	2					
rings	no	no	no	no					

JUPITER

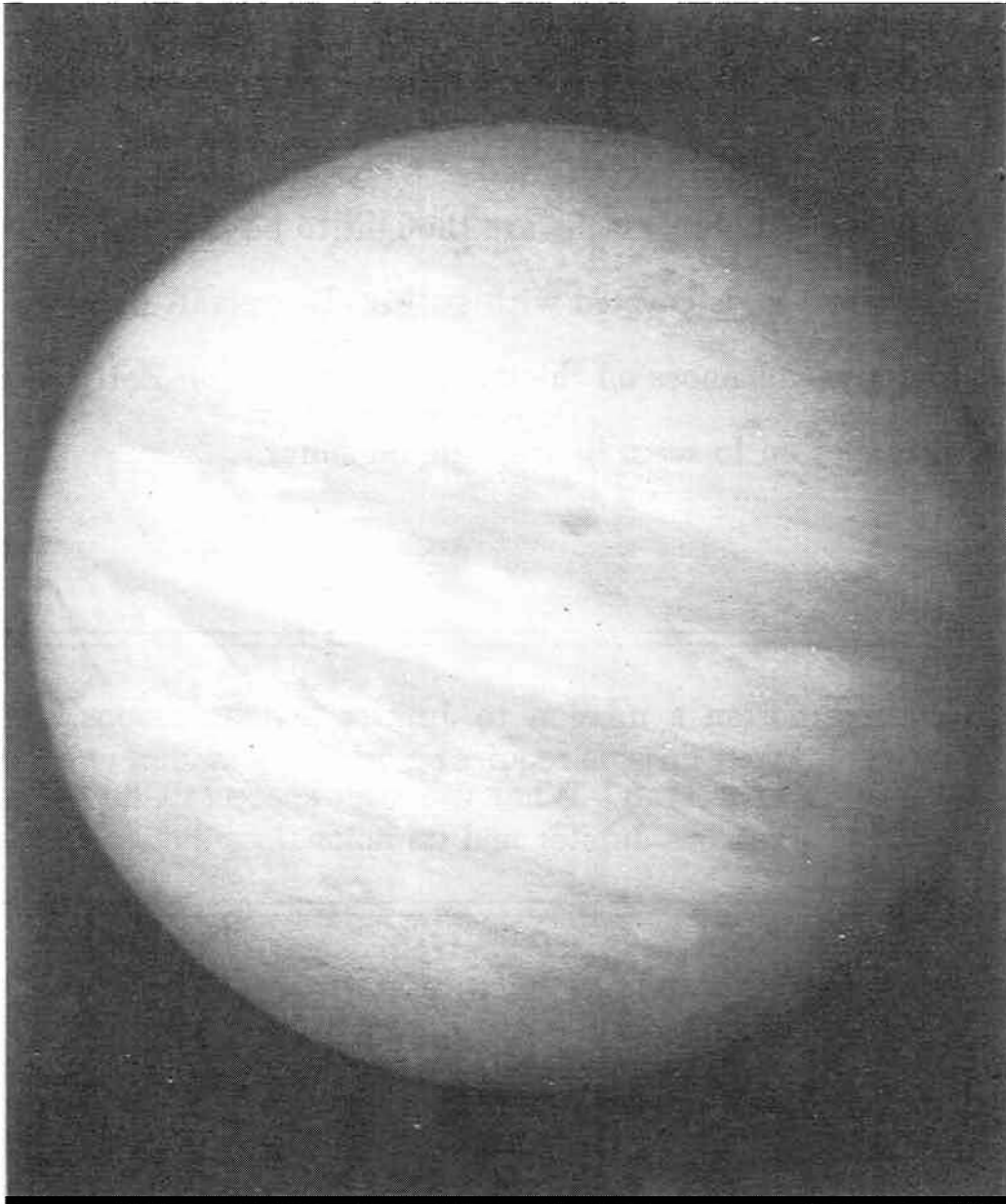
Jupiter is the fifth planet from the sun. Because it is so far from the sun, its temperature is only -220°F (-140°C) at the cloud tops.

All that astronomers can see when they look at Jupiter through a telescope are the tops of the clouds in its atmosphere. These clouds are made of frozen gases such as **ammonia** and water. These colorful clouds cover the entire planet, making it look white, brown, red, and orange. Jupiter's Great Red Spot is a storm which has been going on for over 300 years!

The atmosphere is mainly made of two gases, **hydrogen** and **helium**. Deep in the atmosphere the gases are pressed together so much that they turn into liquid. It would be impossible to land a spacecraft on Jupiter. The pressure deep in the atmosphere is so great that a spacecraft would be crushed. Scientists think that at the very center of Jupiter there may be a core of ice and rock about the size of Earth.

The United States sent several spacecraft to fly by Jupiter. These spacecraft took pictures of the planet and its icy and rocky moons. They discovered thin **rings** around the planet.

Jupiter's four largest moons are called the Galilean moons. They were discovered by Galileo, the first person to use a telescope to look at the heavens. These four moons are very large. Some are even larger than the smallest planets. Jupiter's moon, Ganymede, is the largest moon in our solar system. (The chart on page 34 shows the sizes of the nine planets



Jupiter. When we look at Jupiter we see the clouds in its atmosphere. We can also see the Great Red Spot.

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
moons	0	0	1	2	16				
rings	no	no	no	no	yes				

and some of the moons in our solar system.) Jupiter's smaller moons are probably made of rock.

Three of the Galilean moons are thought to be made of ice and rock. The fourth moon, Io, is covered with **sulfur**. Spacecraft flying by Io took pictures of active volcanoes on this moon. Volcanoes on Earth erupt **lava**, but the volcanoes on Io seem to erupt liquid sulfur.

Challenge: Plan a mission to Jupiter and its moons. Will your mission require an orbiter, a lander, or a flyby spacecraft? What will your spacecraft do when it reaches Jupiter and its moons?

SATURN

Saturn is the sixth planet from the sun. It is a lot like Jupiter.

The temperature at Saturn's cloud tops is -285°F (-175°C). When astronomers look at Saturn through a telescope they see the cloud tops. These clouds are made of frozen gases such as ammonia and water. Saturn's clouds are not as colorful as those covering Jupiter.

Saturn's atmosphere is similar to Jupiter's atmosphere. It is mainly made of two gases, hydrogen and helium. Deep in the atmosphere the gases are pressed together so much that they turn into liquid. A spacecraft traveling down through the atmosphere of Saturn would have the same problem as a spacecraft traveling through the atmosphere of Jupiter. The pressure is so great that a spacecraft would be crushed. Scientists think that at the very center of Saturn there may be a core of ice and rock about the size of Earth.

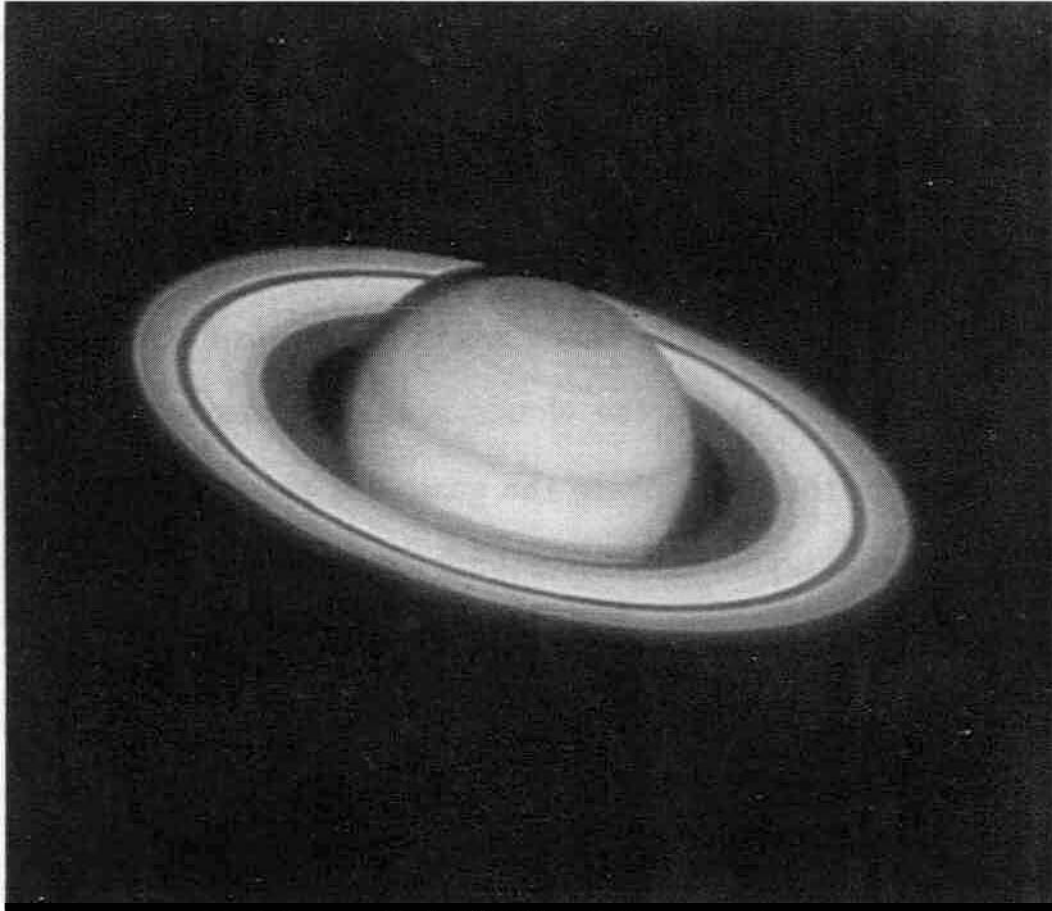
The United States sent several spacecraft to fly by Saturn. These spacecraft took pictures of the planet, its moons, and its rings. Saturn has the most spectacular rings in the solar system. These rings are made of billions of small chunks of ice and rock. Each of these pieces is like a tiny "moonlet" that orbits Saturn just as the big moons do. Even though these wide rings stretch out far beyond Saturn's cloud tops, they are probably less than 100 feet (30 meters) thick!

Saturn's largest moon, Titan, is the second largest moon in the solar system. It is larger than some planets. (You can use the chart on page 34 to

compare Saturn and Titan to other objects in the solar system.) Titan has an atmosphere of nitrogen and **methane**. We have never seen the surface of Titan because its sky is filled with a haze similar to smog. Scientists believe that the surface of Titan may be covered by an ocean of liquid methane.

The next six largest moons appear to be made mostly of ice. The smaller moons are probably made of rock or ice and rock.

Challenge: How do you think Saturn's rings formed? Why don't the chunks of ice melt?



Saturn. When we look at Saturn we see its clouds. We can also see its beautiful rings!

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
moons	0	0	1	2	16	18			
rings	no	no	no	no	yes	yes			

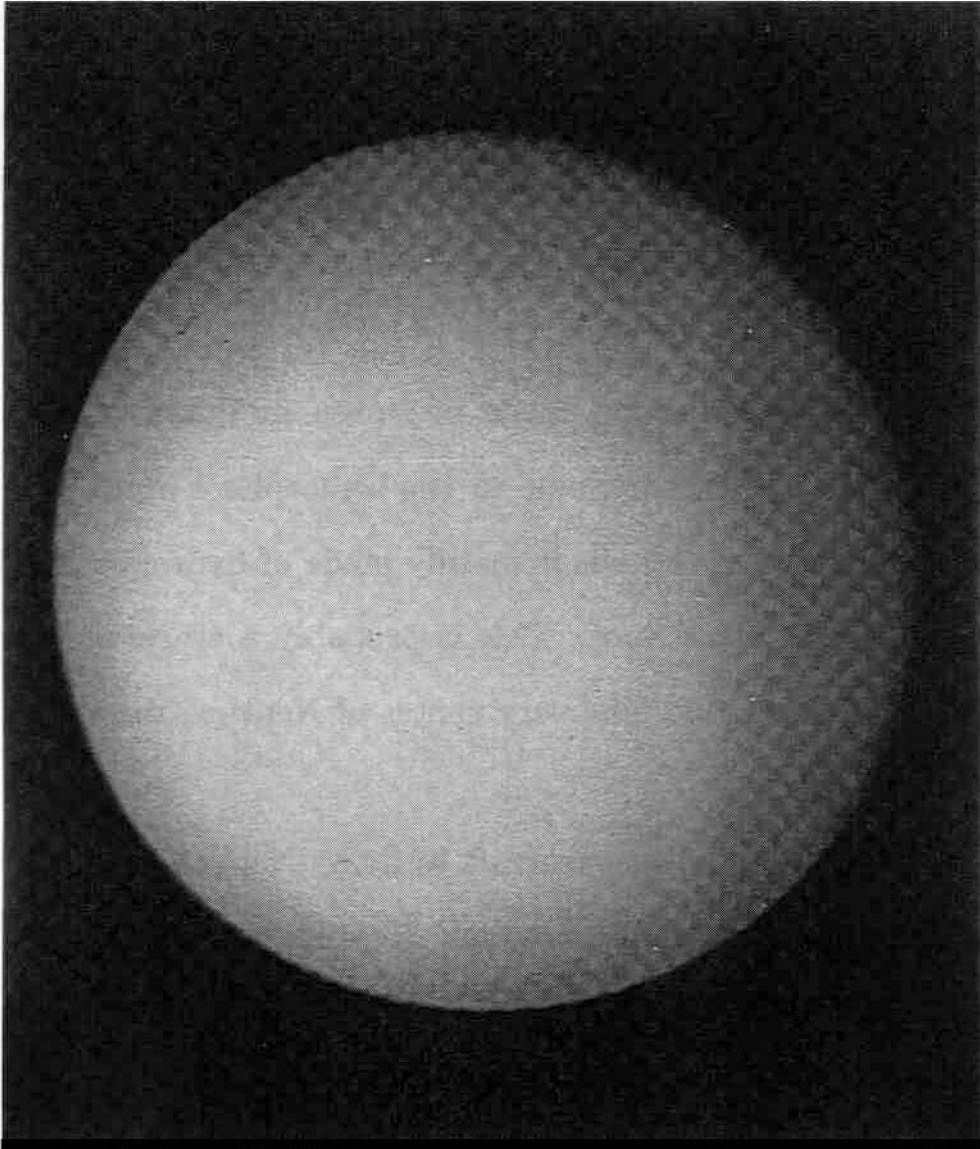
URANUS

Uranus is the seventh planet from the sun. When astronomers look at Uranus through a telescope they see some clouds and the atmosphere above the clouds. These clouds are made of frozen methane. Methane is a gas which we use for cooking and heating on Earth. The temperature at the top of the clouds is -370°F (-220°C). The clouds of Uranus appear bluish-green because of the methane gas in the atmosphere above them.

The atmosphere below the clouds is mainly made of hydrogen and helium. Deep in the atmosphere the gases are pressed together so much that they turn into liquid. Scientists think that at the very center of Uranus there may be a core of ice and rock.

The United States sent a spacecraft to fly by Uranus. It took pictures of the planet and its rings and moons. The moons are probably made of ice and rock.

Challenge: If you landed on one of the moons of Uranus, what do you think you would see in the sky?



Uranus. Uranus is covered with clouds. The clouds look blue-green.

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
moons	0	0	1	2	16	18	15		
rings	no	no	no	no	yes	yes	yes		

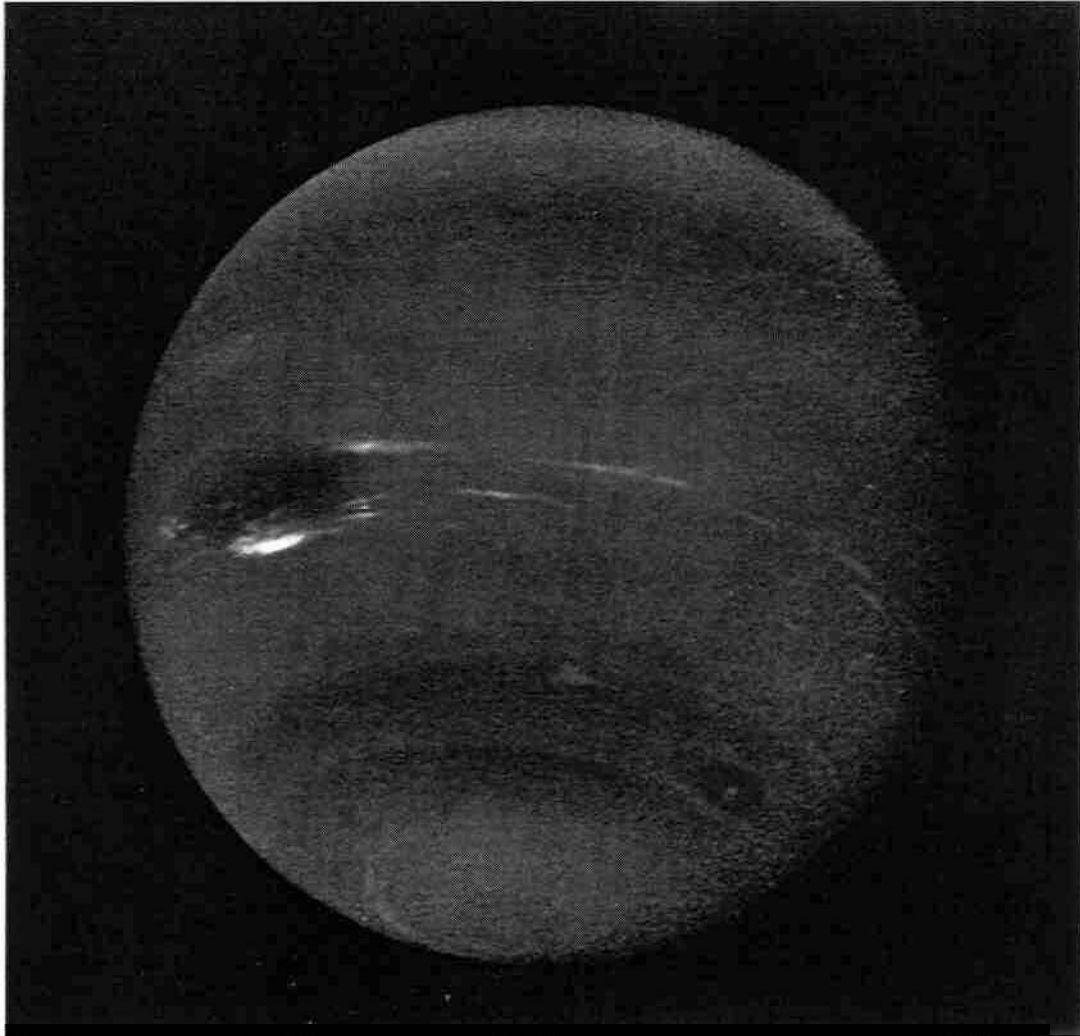
NEPTUNE

Neptune is usually the eighth planet from the sun. Sometimes Pluto moves closer to the sun. Then Neptune is the ninth planet from the sun for a while. The temperature on Neptune above the clouds tops is -355°F (-215°C).

The clouds of Neptune are made of frozen methane. These clouds appear blue because of the methane in the atmosphere above the clouds. The atmosphere below the clouds is mainly made of hydrogen and helium. Neptune has a Great Dark Spot. This is probably a storm similar to the Great Red Spot on Jupiter. The very center of Neptune may be a core of ice and rock.

The United States sent a spacecraft to fly by Neptune. The spacecraft took pictures of the planet and its moons. Neptune's largest moon, Triton, has a surface of frozen nitrogen and methane. Pictures of Triton show features that appear to be volcanoes erupting liquid water and ammonia. The smaller moons are probably made of rock or ice and rock.

Challenge: Jupiter, Saturn, Uranus, and Neptune are called the **gas giants**. How are these four planets alike? How are they different?



Neptune. When we look at Neptune we see its blue clouds. We can also see the Great Dark Spot.

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
moons	0	0	1	2	16	18	15	8	
rings	no	no	no	no	yes	yes	yes	yes	

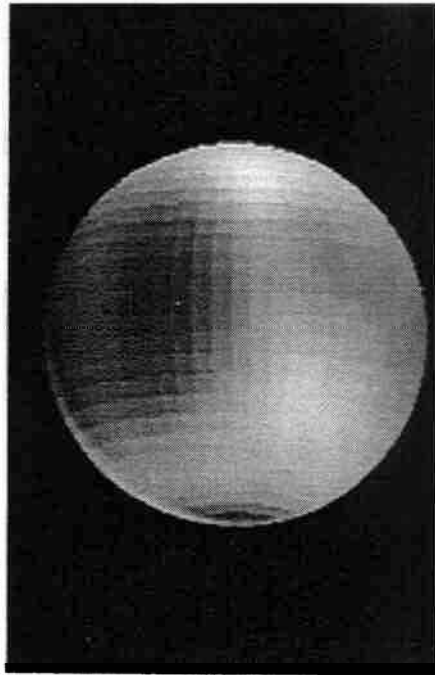
PLUTO

Pluto is usually the ninth planet from the sun, making it the farthest known planet from the sun. Sometimes Pluto's orbit crosses the orbit of Neptune. When it does, Neptune becomes the farthest planet from the sun. From 1979–1999 Pluto is the eighth planet from the sun and Neptune is the ninth.

The temperature on the surface of Pluto is about -370°F (-220°C). Pluto has a thin atmosphere of methane and perhaps some nitrogen. The planet's surface is methane frost. Scientists think that Pluto is made of methane ice, water ice, and some rock. Pluto is so far away from the sun that a day on Pluto is only as dusk on Earth!

Scientists must study Pluto from Earth. It is the only planet in our solar system that has not been visited by a spacecraft.

Challenge: Pluto is the farthest known planet from the sun.
What do you think you would find beyond Pluto?



Pluto. We have only seen Pluto from far away. It looks like a point of light.

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
moons	0	0	1	2	16	18	15	8	1
rings	no	no	no	no	yes	yes	yes	yes	no

Image courtesy of Marc. W. Buie/Lowell Observatory.

ASTEROIDS, METEOROIDS, METEORS, AND METEORITES

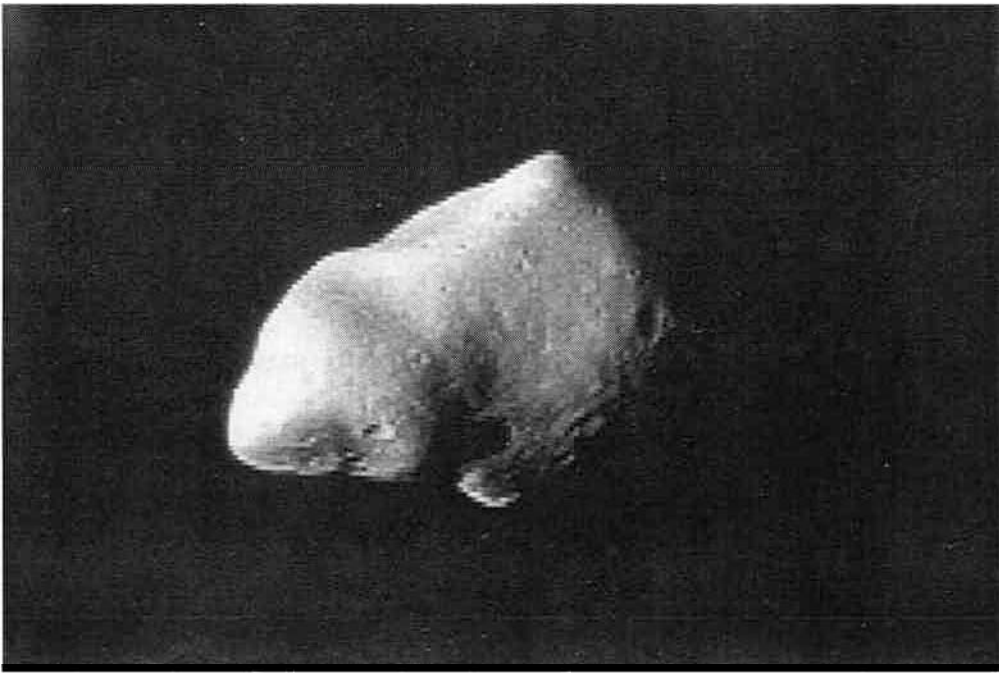
Most **asteroids** orbit the sun between the orbits of Mars and Jupiter. This region is called the **asteroid belt**. However, some of them have orbits that can bring them near Earth.

Asteroids are made of rock and iron like the four planets closest to the sun. They are called minor planets because they are so small. If an object the size of an asteroid looks fuzzy through the telescope, then we call it a **comet**.

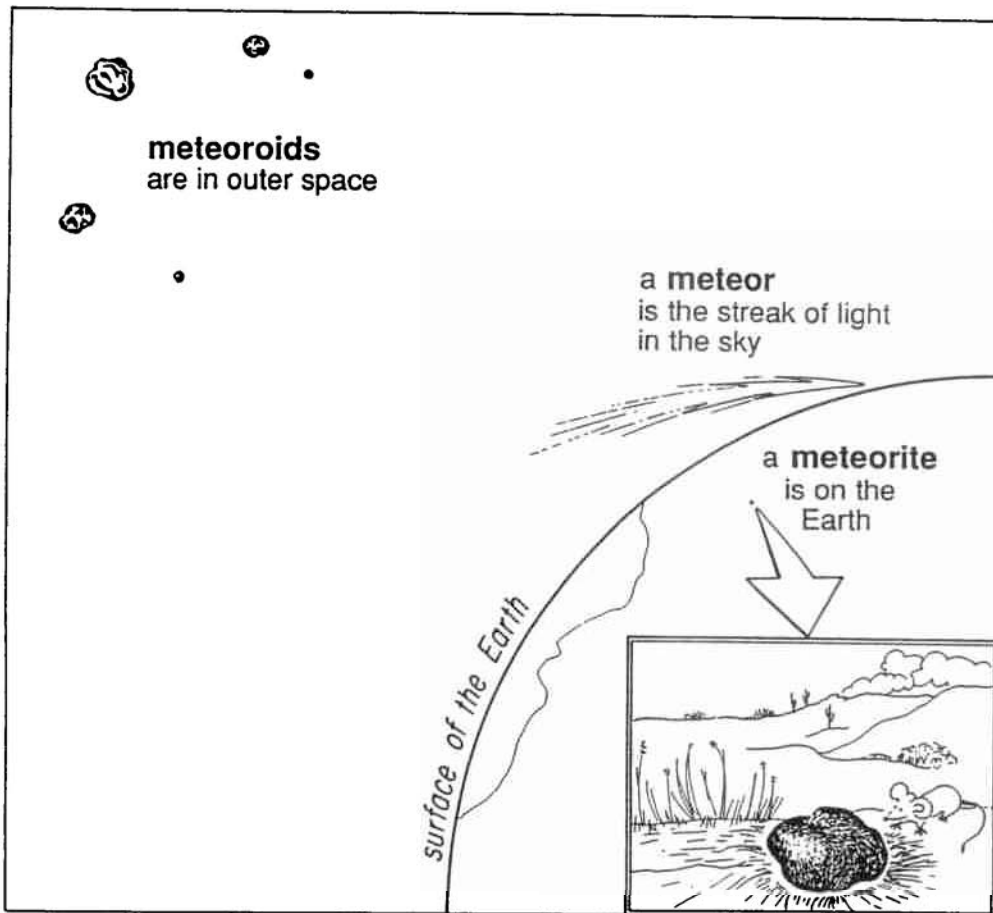
Asteroids are of interest to scientists because asteroids are made of some of the same materials that make up the planets. In fact, scientists think that early in the history of the solar system asteroid-like bodies colliding with each other grew to become the planets. Because asteroids are so small, they have changed very little since they formed early in the history of the solar system. In 1991 an American spacecraft took the first pictures of an asteroid. The asteroid has a very irregular shape.

Sometimes asteroids collide to form *smaller* asteroids. The collisions can also form **meteoroids**, which are *even smaller* pieces of rock and iron. Some meteoroids also come from comets. Meteoroids orbit the sun just as the asteroids, comets, and planets do.

Sometimes the orbits of the meteoroids bring them near Earth. If they enter Earth's atmosphere, they heat up and make the air around them glow.



An asteroid as seen close-up from a spacecraft.



The light we see is called a **meteor**. Some people call these **shooting stars**. If the meteoroid is big enough to survive its trip through the atmosphere and land on the surface of Earth, it is called a **meteorite**. When someone is lucky enough to find a meteorite, scientists can study actual pieces of material from space.

Challenge: What do you think you should do if you find an object you think is a meteorite? What would happen if an asteroid hit Earth?

COMETS

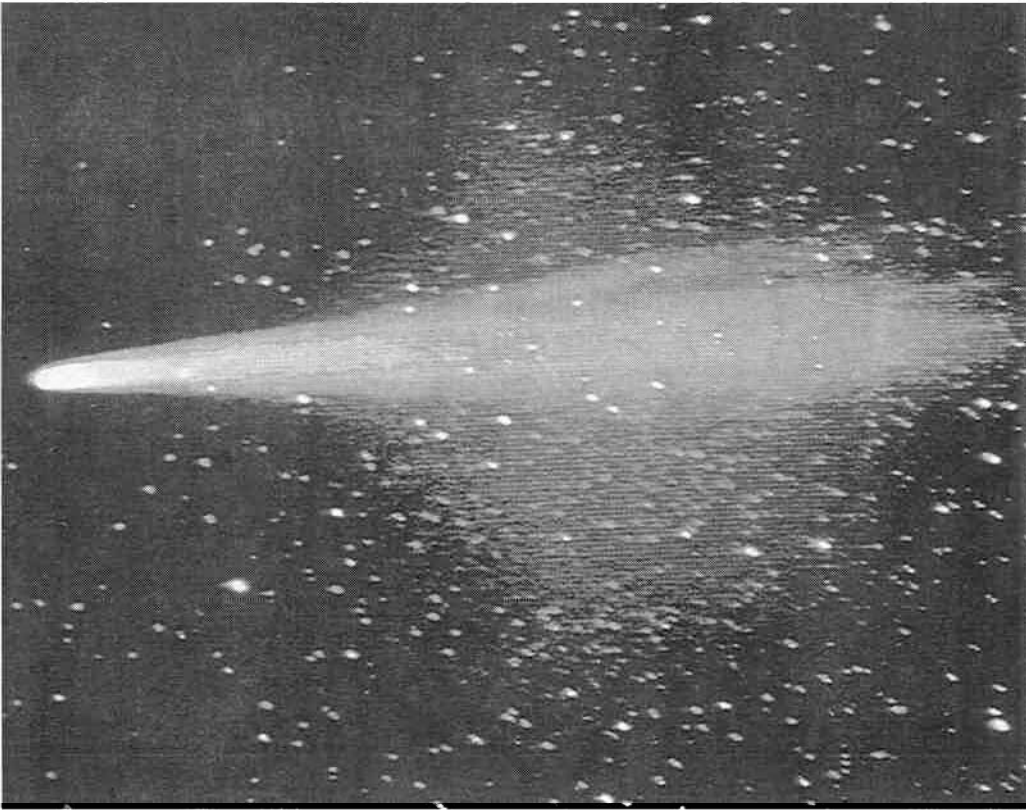
Comets orbit the sun in the same way that planets orbit the sun. Most comets have orbits that are far beyond the orbit of Pluto. Some have orbits that bring them closer to the sun than the orbit of Mercury.

Comets are very small bodies made of ice and dust. When comets are far from the sun, they are too small and cold for us to see them. When they get close to the sun, their ices warm up and turn to gas. Some of the dust is carried away from the surface of the comet by the gas. The gas and dust are what we can see from Earth. The solid part of a comet is called the **nucleus**. The large cloud of gas and dust around the comet is called the **coma**. This cloud makes the comet look fuzzy through a telescope. Some of the gas and dust from the coma flows away from the comet; this is called the comet's **tail**. The tail always points away from the sun.

Comets are of interest to scientists because they think comets are made of some of the same materials that make up the planets. Comets may have collided with each other and with the asteroids to grow into the planets we know today. Because comets are so small, they have changed very little since they formed early in the history of the solar system.

When Comet Halley came near the sun in 1985, the Soviet Union, Europe, and Japan sent spacecraft to study the nucleus of the comet. This was the first time that scientists had ever seen the solid part of a comet.

Challenge: Go to the library and look up articles and books on the history of comets. What did people think about comets hundreds of years ago?

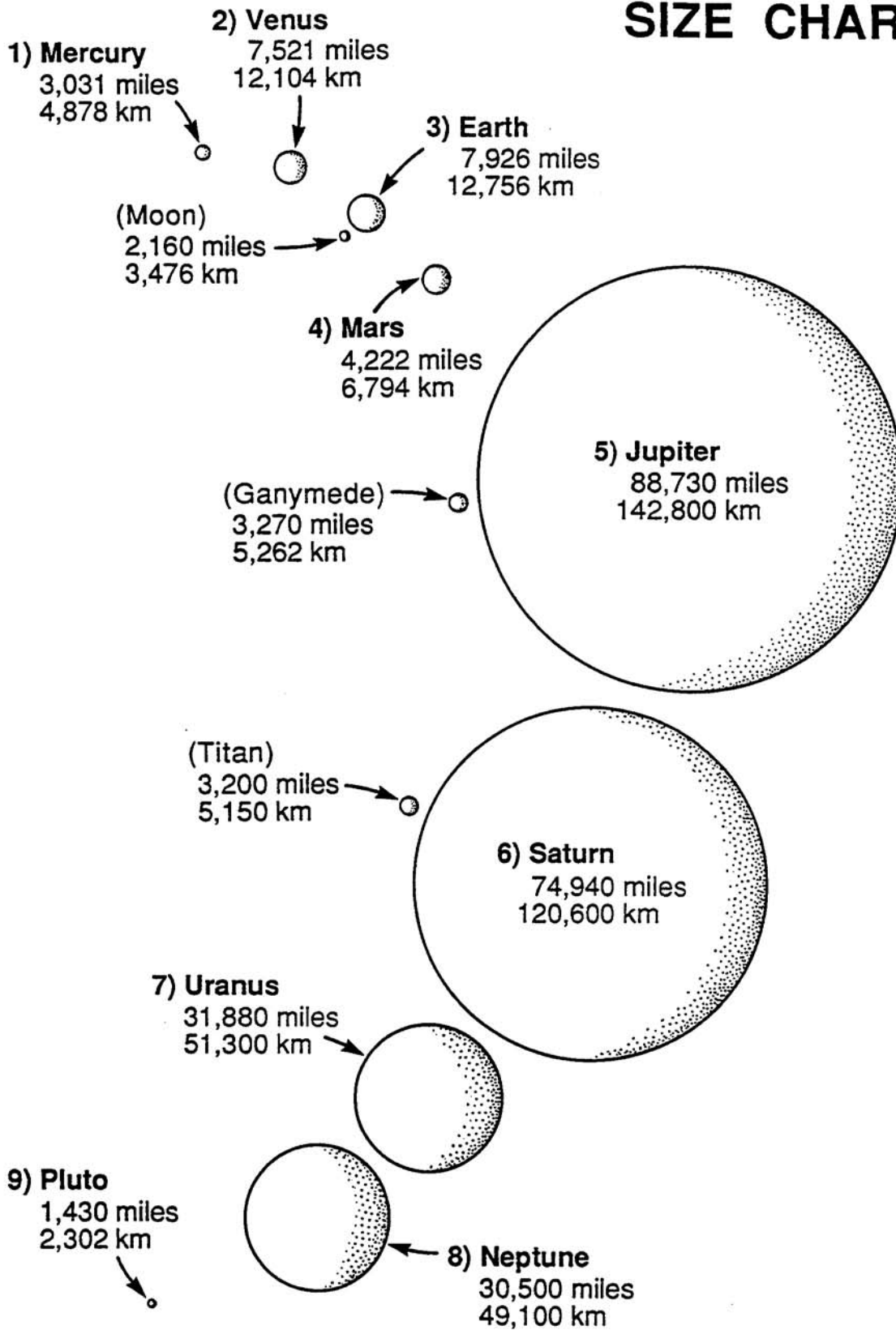


(a) Comet Halley as seen through a telescope on Earth.



(b) Comet Halley as seen close-up from a spacecraft.

SIZE CHART



DO YOU REMEMBER?

Which planet is closest to the sun?

Which planet is the hottest?

Which planet has people, plants, and animals?

Which planet has red soil?

Which planet is the largest?

Which planet has the most spectacular rings?

Which planet has a Great Dark Spot?

Which planet is the smallest?

Which planets do not have moons?

Which planet is the coldest?

Which planets have hard, rocky surfaces?

Which planets have methane gas in their atmospheres?

What is the correct scientific name for a shooting star?

What are the three parts of a comet?

DESIGN A PLANET

Imagine that there are two more planets in our solar system. One is located between Mars and Jupiter. The other is located beyond Pluto. Choose one of these “new” planets, then complete the following activities.

1. Describe your planet. Think about its surface, temperature, and atmosphere. Think about possible life forms. Does your planet have rings? moons? clouds? volcanoes? frost? boiling gases? Make a model (map, drawing, papier mâché, clay, plaster of Paris) of your planet.

2. Find out how the other planets in our solar system were named. How were their moons, if any, named? Name your planet (and its moons, if there are any). Explain why you chose these names.

3. If humans could reach your planet and set up a research station, what hazards would they face? What kind of structure would they need to protect them? Could they breathe? Could they travel on the surface? Why would they want to visit your planet? What could they learn? Make a model of the research station humans might construct on your planet.

Glossary

ammonia – a colorless gas made of nitrogen and hydrogen. It has a sharp smell. It can be mixed with water and used for household cleaning.

asteroid – one of thousands of small bodies made of rock and iron which orbit the sun, generally between the orbits of Mars and Jupiter. Asteroids can be less than one mile to almost 600 miles in diameter.

asteroid belt – the region in the solar system where most of the asteroids orbit around the sun. The region is between Mars and Jupiter.

atmosphere – gases surrounding any of the bodies in space; air.

canyon – a deep valley with steep sides.

carbon dioxide – a colorless and odorless gas. Plants on Earth need carbon dioxide to live.

cliff – a very steep, high wall of rock.

coma – the gas and dust that surround a comet's nucleus.

comet – a body made of ice, dust and gas that travels in a path around the sun. The parts of a comet are called the nucleus, coma, and tail.

crater – a hole in the surface of a planet, moon, or asteroid made when an object (asteroid, meteoroid, or comet) crashes into it with great force.

ellipse – a flattened circle.

gas – a substance, such as oxygen or hydrogen, that has no fixed shape and that can expand without limit.

gas giants – the four planets we call Jupiter, Saturn, Uranus, and Neptune. They are the largest planets in the solar system and are made mostly of gas.

greenhouse effect – a condition that results when a gas in the atmosphere, such as carbon dioxide, traps heat from the surface of a planet.

helium – a colorless and odorless gas that does not burn or explode. This gas is very light and is used to inflate balloons.

hydrogen – a colorless and odorless gas that burns easily.

lunar – relating to the moon.

meteor – a streak of light caused by a meteoroid that heats up as it travels through Earth's atmosphere. Some people call a meteor a shooting star.

meteorite – a meteoroid that lands on Earth's surface.

meteoroid – a small body in space, smaller than an asteroid, made of rock, metal, and ice. Meteoroids are thought to be pieces of asteroids and comets.

methane – a colorless and odorless gas that burns. It is often used as a fuel for heating homes and cooking food.

moon – a body which orbits a planet.

mountain – land that rises to a great height.

nitrogen – a colorless and odorless gas that makes up the largest part of Earth's atmosphere.

nucleus – the central, solid part of a comet made of ice and dust.

orbit – n. the curved path a body takes when it moves around another body; vb. to travel in an orbit.

oxygen – a colorless and odorless gas that is needed by people and animals to live.

planet – one of nine bodies that orbit the sun and shine by reflecting light from the sun. The nine planets in order of distance from the sun are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. Planets are also thought to orbit other stars, but none has ever been seen from Earth.

radar – a device to determine the distance and direction of movement of an object. Radio waves are sent out and reflected back from an object.

shooting star – what some people call a meteor.

solar system – the sun, the nine planets and their moons, asteroids, comets, and meteoroids that orbit the sun.

spacecraft – a vehicle made to travel in the solar system. A spacecraft can either fly by, orbit, or land on the object it is studying.

star – a ball of hot, glowing gases that shines with its own light.

sulfuric acid – an oily, colorless liquid made of hydrogen, sulfur, and oxygen.

sun – the star closest to Earth. The center of the solar system. A ball of hot, glowing gases which gives Earth heat and light.

surface – the outermost solid or liquid layer of an object.

tail – the gas and dust from the coma that flow away from the nucleus and coma of the comet.

valley – low-lying region between mountains or hills.

volcano – an opening in the surface of a planet or moon through which lava, ashes, and gases flow. Volcanoes on some moons spew out water or liquid sulfur.

water – a colorless and odorless liquid made of hydrogen and oxygen.