SOLAR SYSTEM

Teacher Guide

including

Lesson Plans, Student Readers, and More Information

Lesson 1 - Searching for Planets

Lesson 2 - Inner Planets/Outer Planets

Lesson 3 - Planetary Information Lab

Lesson 4 - Solar System Characters Lab

Lesson 5 - Comets - A Story

designed to be used as an Electronic Textbook
in class or at home

materials can be obtained from the Math/Science Nucleus

EARTH SCIENCES - SOLAR SYSTEM

Lesson 1 - SEARCHING FOR PLANETS

MATERIALS:
reader

Objective: Students learn about how difficult it is to "discover" planets.

SEARCHING FOR PLANETS

Teacher note

Our Solar System is dominated by gravitational attraction of the Sun. The planets revolve around the Sun in a slightly elliptical orbit and in a flat plane. They are always close to the ecliptic, so they are only seen not far from our horizon. Some planets like Pluto are highly eccentric and cuts through the orbit of Nepture during some years. As you travel away from the Sun the orbits take longer and longer. Mercury takes about 88 days, while Pluto takes 248 years. The planets tend to revolve around the Sun in a counterclockwise direction.

Emphasize with students the difference between revolution (orbit around another body) and rotation (spinning on itself or axis). All the planets rotate on an axis, some faster than others. For example the gas planets like Jupiter rotate on its axis once every 10 hours. Venus, a much smaller planet actually takes longer to rotate, almost 243 days to spin just once! The gas planets in general go faster than the terrestrial. The planets rotate in a counterclockwise direction with the only exception of Venus which rotates the opposite direction (clockwise).

ANSWERS: 1. Missing a planet; comet would not be that large, orbits are not

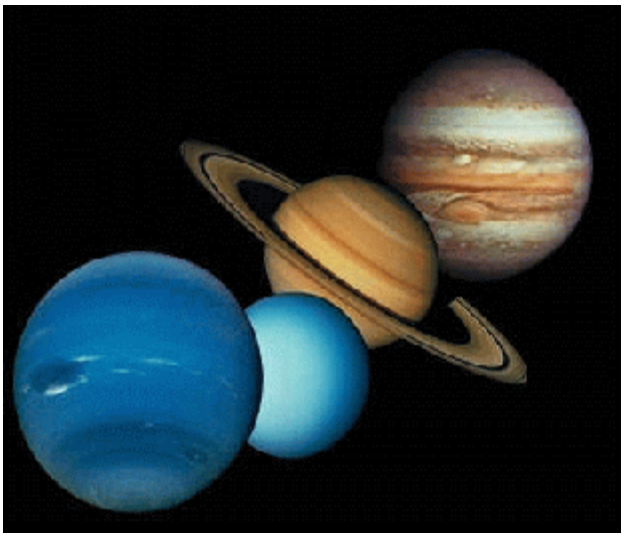
There is more than knowing the order of the planets and their names. The planets of the Solar system all have their own unique characteristics. You can group the planets into terrestrial and gaseous planets. Terrestrial are those inner planets of Mercury, Venus, Earth, and Mars that are composed mainly of rock. Pluto is also a terrestrial planet, but it is part of the outer planets.

Terrestrial planets.

Jupiter, Saturn, Neptune, and Uranus are considered the gas giants. They are thousands of times larger than the terrestrial planets. Their surface is composed of tens of thousands of kilometers of a sea of liquid gaseous material.

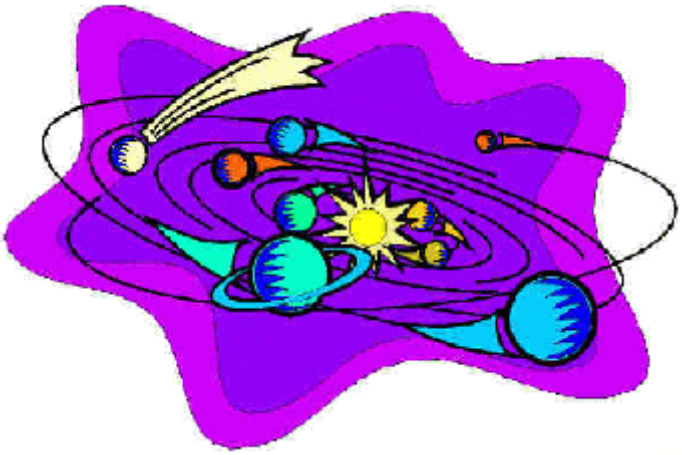
Let's look at how ancient people first started to see the difference between a star and a planet. Then we will compare and contrast each of the planets and their associated moons.

Look at the following pictures and see if you can tell what is wrong with each picture.



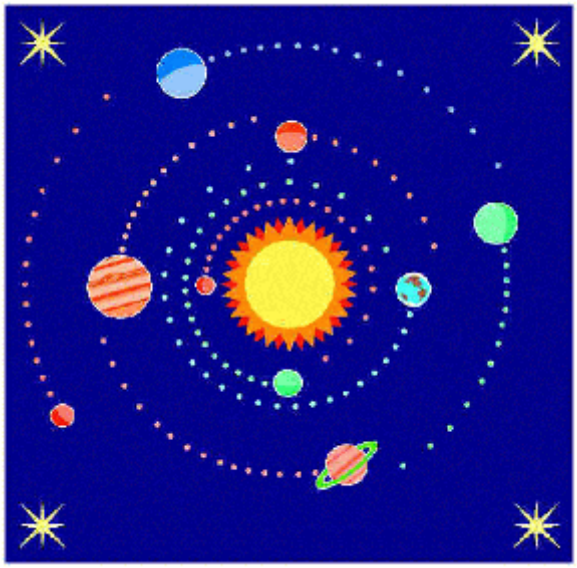
Gas planets.

What is wrong with these planet pictures?



1. Hint: The orbits are OK, but there are 2 major mistakes. Name them.

2. Hint: Something to do with the orbit.



3 .

Hint: Something wrong with the view.

Discovering the Planets

Teacher note

Discovering the planets was a difficult job. Untrained eyes see the "bright" spots in the sky and assume they are stars. Years of watching and tracking the spots reveal that 5 such bright spots that can be seen with the naked eye move differently and can only be seen along the Earth's horizon.

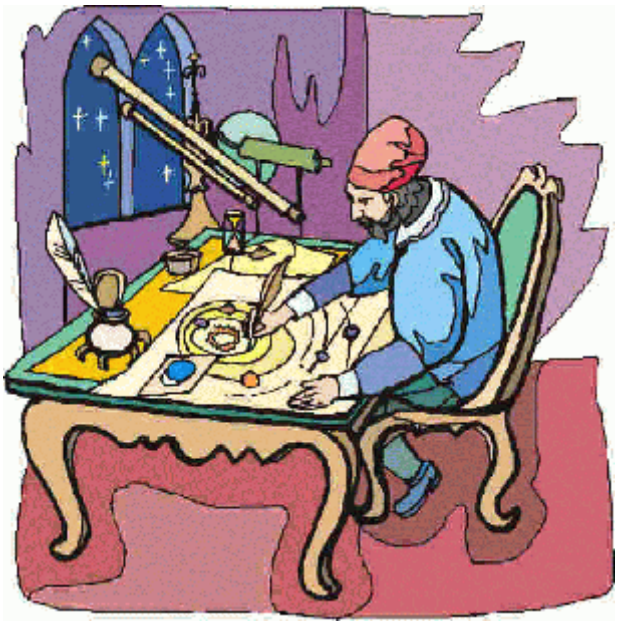
Early people where able to recognize 5 planets, but the search for Uranus, Neptune, and Pluto took years of searching. The invention of the telescope allowed for their discovery.

The night sky is one of the most beautiful sights in nature. Imagine looking up and seeing all those points of light, and not knowing what they are. How could you detect the **planets** amongst all those stars. Stars generate their own light so they shine bright, but a planet reflects the light from the Sun and still appears as a star.

Egyptians carefully watched the Sun for years and recorded the sunrises and sunsets. They were the first to record that the position of stars in the heaven repeats after 365 sunrises and sunsets. They realized that there are 7 planetary bodies that moved, the Sun, the Moon, and 5 planets. They believed the planets to be gods whose movements would reveal themselves sometimes in the future.

Movement of the Sun and planets in relationship to the stars have always been a problem. The ancient Greeks provided a system developed by **Ptolemy** (90-168), where the Earth is the center of all movement. The Sun and other stars revolve around us. This sounds logical, until you really look at the night time sky.

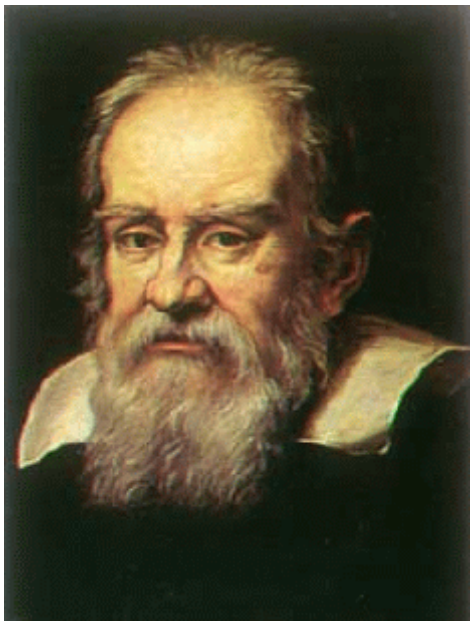
Nicholas **Copernicus** (1473-1543), from what is now Poland, disposed of the Earth as the Universe's center, by placing the Sun in the central position, with the planets (including Earth) revolving around the Sun. Copernicus was the first of many people in the 1600's who started to develop a scientific way of looking at the skies.



Copernicus charting planet movement.

Galileo Galilei, an Italian used his "optic tube" **telescope**. to look into the night time sky to see things never observed before. **Kepler** developed mathematical models to explain motion, which helped to allow humans to predict what is going on. Galileo's inquiry on motion would be used by **Sir Isaac Newton** to uncover more mysteries of the Universe. Newton's law of motion would take astronomy to a new scientific level.

Let's take a tour of the Solar System, just our little corner of the Universe. We are still learning new and exciting facts about each planet, as scientists from around the world search for understanding each of the planets.



Galileo Galilei

EARTH SCIENCES - SOLAR SYSTEM

Lesson 2 - INNER PLANETS/OUTER PLANETS

MATERIALS:
reader

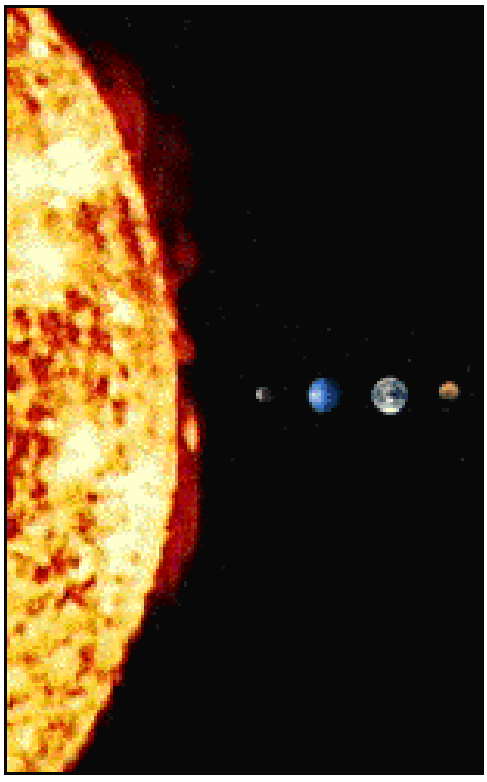
Objective: Students compare and contrast the planets of our Solar System.

THE INNER PLANETS

Teacher note

It is important for students to compare and contrast the different planets. As we begin to explore each of the planets in detail through better technology, some of the details will change, but the base information will probably not.

The internet can play a role to keep the students updated on the planets. National Aeronautics and Space Agency (NASA) maintains websites to keep your students alerted of any new discovery in planetary space (http://sse.jpl.nasa.gov).



The Sun's **gravity** holds the inner planets tightly as they revolve around the Sun. The orbits of Mercury, Venus, Earth, and Mars revolve faster than the outer planets because they have less distance to travel. They **revolve** around the Sun all within a relatively **flat plane**.

The inner planets are rock and are relatively small **bodies.** They don't have more than 2 satellites (Mars), with Venus and Mars having none. Mercury and Venus rotate on their **axis** slower than any of the other planets. Venus is the only planet that rotates **clockwise**, the other planets rotate on their axis **counterclockwise.** Mercury has a very **eccentric** orbit, similar to Pluto as it revolves around the Sun. The inner planets do not have any rings like the gas giants.

MERCURY

Teacher note

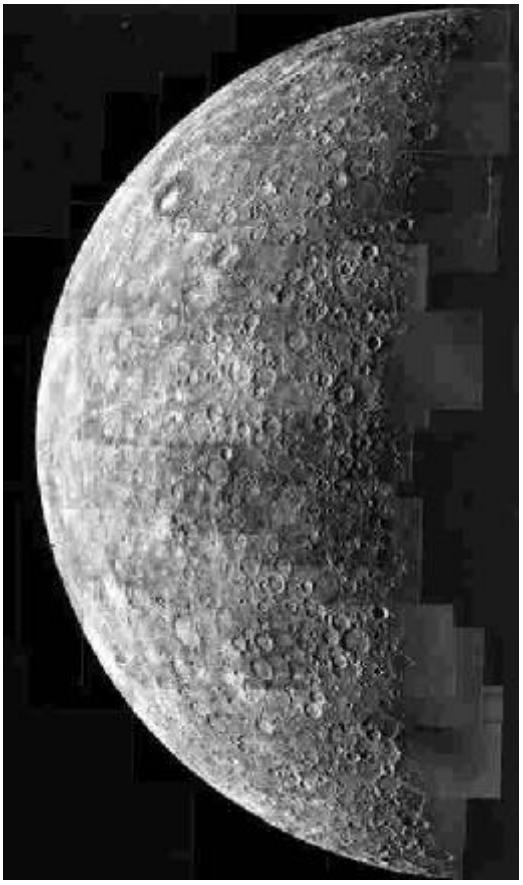
Mercury is the closet planet to the Sun. Mercury's diameter is about 40% of the Earth, and its mass is only 6% of the Earth's. The high density of Mercury has implied that there is a large iron or nickel-iron core inside the planet. This iron core is probably molten and responsible for Mercury's magnetic field.

Mariner 10 in 1974 has photographed about 40% of Mercury's surface. They found extensive cratered highlands, which imply a very old surface. Dark, smooth plans, similar to the Moon's maria are also present. Some of the observed craters are giant impact basins like those found on the Moon. The largest is 1,300 km in diameter is called the Carloris Basin. There are also large, long scarps or one-sided ridges that cross the surface of the cratered highland. These scarps are thought to have formed by contraction of the crust as Mercury's large core cooled and partially solidified.

If an explorer were to step onto the surface of Mercury, he would discover a world resembling **lunar terrain**. Mercury's rolling, dust-covered hills have been eroded from the constant **bombardment** of **meteorites**. Craters dot the surface.

Mercury, the closest planet to the Sun, was named by the Romans after the **fleet-footed** messenger of the gods because it seemed to move more quickly than any other planet. But is it?

This **photomosaic** of Mercury was constructed from photos taken by **Mariner 10** six hours before the spacecraft flew past the planet on March 29, 1974. These images were taken from a distance of 5,380,000 kilometers (3,340,000 miles). (Courtesy USGS, and NASA)



VENUS

Teacher note

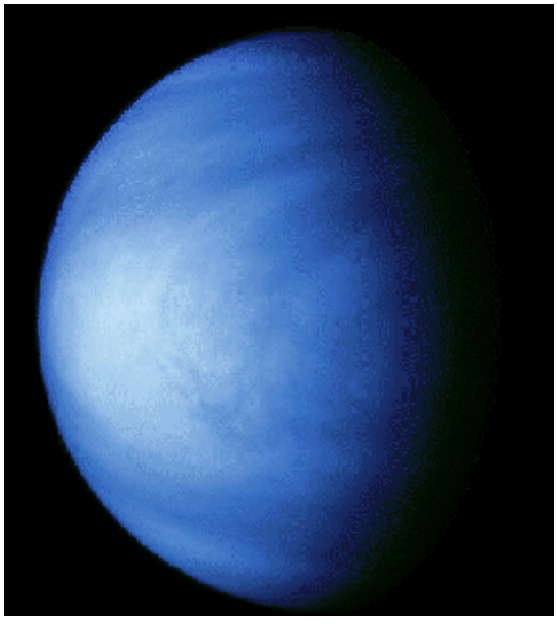
There are many geologic features on Venus. After 80% of the surface has been mapped (1991), scientists feel that 75% of the features are volcanic and 25% is tectonic. Tectonic refers to movement after they were created. There are mountain belts, rift zones, concentric rings of ridges and grooves, parallel ridges, and densely packed ridges and grooves that intersect at various angles.

No volcanoes seem to be active, but scientists think that tectonic activity is continuing within the planet. No Venusian surface feature appears to be more than a billion years old. A probe in 1972 found granitic rock, similar to Earth's continental rock and a probe in 1975 found basalt, which is a common volcanic rock. The Greenhouse Effect, which traps heat between the land and the clouds is responsible for the planet's extremely high temperatures.

Carbon dioxide makes up 98% of its atmosphere. Other constituents include nitrogen (2%) and a few parts per million of helium, neon, and argon. Recent information has shown that .1%-.4% of the atmosphere is water vapor and 60 parts per million of free oxygen, an indication that Venus at one time had abundant water, but has since lost it.

Venus, the jewel of the sky, was once known by ancient astronomers as the morning and evening star. Venus, which is named after the Roman goddess of love and beauty, is veiled by a thick swirling cloud cover. As the goddess of love, Venus is the "queen of pleasure" and mother of the Roman people. Venus is also a nature goddess, associated with the arrival of spring. She brings joy to gods and humans.

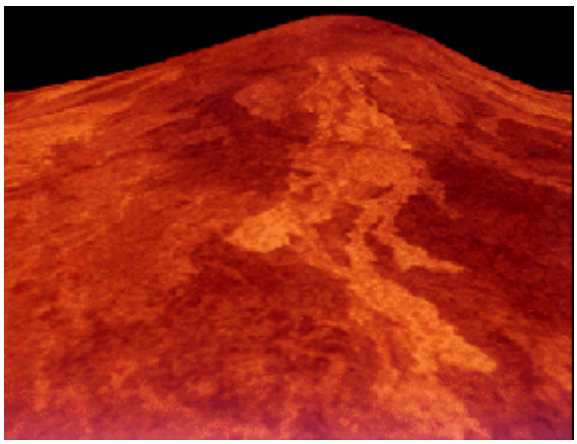
Astronomers refer to Venus as Earth's **sister planet**. Both are similar in size, **mass**, **density**, and volume. However, during the last few years scientists have found that the kinship ends here. Venus is very different from Earth. It has no oceans and is surrounded by a heavy atmosphere composed mainly of **carbon dioxide** with virtually no water vapor. Its clouds are composed of **sulfuric acid droplets**. At the surface, the **atmospheric pressure** is 92 times that of the Earth's at **sea-level**.



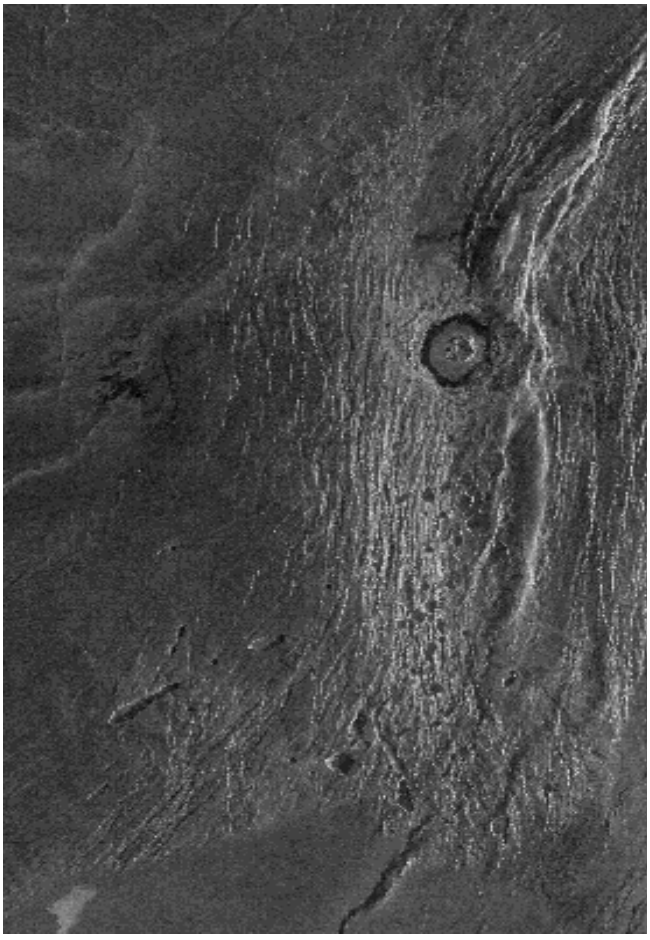
Cloud cover of Venus.

Venus is **scorched** with a surface temperature of about 482/ C (900/ F). This high temperature is primarily due to a runaway **greenhouse effect** caused by the heavy atmosphere of carbon dioxide. Sunlight passes through the atmosphere to heat the surface of the planet. Heat is **radiated** out, but is trapped by the dense atmosphere and not allowed to escape into space. This makes Venus hotter than Mercury.

A Venusian day is 243 Earth days and is longer than its year of 225 days. Oddly, Venus rotates from east to west. Venus rotates clockwise, when all the other planets rotate counterclockwise. To an observer on Venus, the Sun would rise in the west and set in the east.



Sif Mons Volcano generated from Magellan mission is 2 km heigh.



Vires-Akka Mountain range about 1 x4 km. Notice the large impact crater.

Venus is considered contrary to all the other planets. Different, mysterious, like a woman. Astronomy is dominated by male scientists, Venus is the only planet named for a woman.

EARTH

Teacher note

Earth and the Moon follow a oval path around the Sun. The Earth has a tilt (23.45º) which causes the seasons. If a hemisphere is tilted away it will be winter, if tilted toward the Sun it will be summer. Even if the Earth is closest to the un, it is the tilt that make the seasons change. We are about 149,600,000 km from the Sun.

The Earth is known for containing three types of rocks including igneous, sedimentary, and metamorphic. So far, this seems to be unique in the Solar System. But then, we haven't sampled all the planets yet!

Studying the Earth and Moon system is a great time to mention eclipses. An eclipse is when one body shuts off all or part of the light of another, or by an opaque body passing into the shadow of another opaque body.

Which planet has water?

The Earth as a planet, has evolved slowly over the 4.5 billion years of existence. The atmosphere that we now have, is not the same over its long **evolution**. The oceans and lakes were not here when the Earth formed. Evidence shows that it took almost 1 billion years before water was prevalent. The Earth is so different than the other planets because of the creation of water, which was formed with hydrogen and oxygen merged inside the Earth, and **outgassed** when volcanic activity took place. Steam slowly poured from the many volcanoes and created a planet of water.

Land configurations were not the same as they are today. The crust has moved and shifted for billions of years, forming mountains, valleys, and plains. Our **landscape** is a result of all these interactions.

The Earth and its Moon are the most studied of all the planets and **satellites** of the Solar System.

MARS

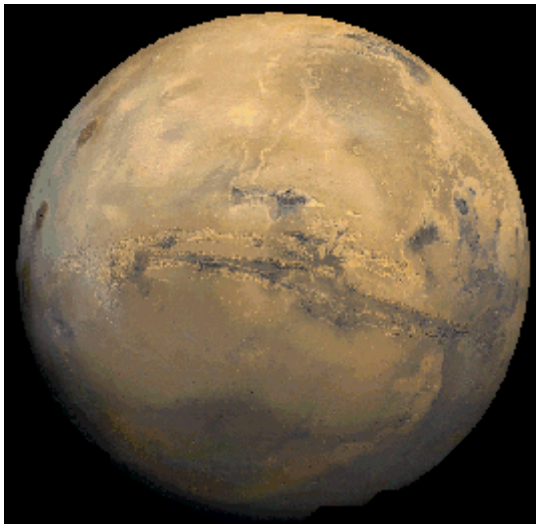
Teacher note

Mars is named for the Roman god of war. It is easily distinguished in the night sky by its reddish appearance. Its density indicates that it is made of rocky materials like the Earth, with less iron and more lightweight elements than the Earth. It is only about half as large of the Earth. Mars has two tiny bodies orbiting Mars discovered in 1877 by Asaph Hall and named Phobos and Deimos.

The darker areas of Mars, call maria change during the Martian season. The spring darkening is due to winds blowing fine bright dust off darker rocks. Dust storms have been observed starting on orange deserts and spread over the entire landscape.

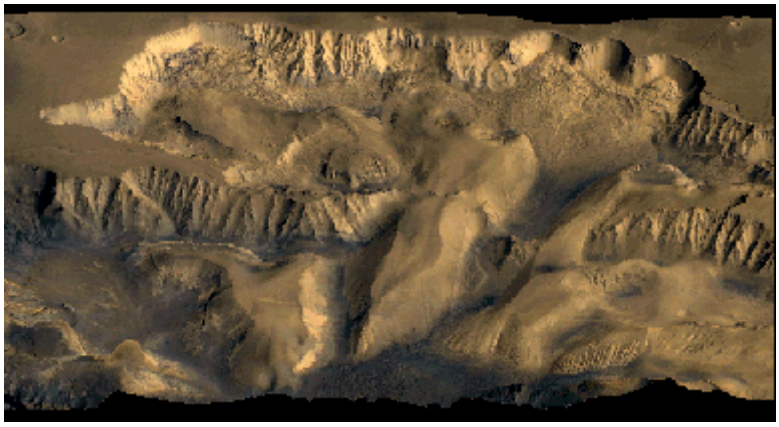
There seems to be four immense volcanic mountains. The largest of these shield volcanoes, called Olympus Mons, makes the Hawaiian volcanoes look small. There are a great number of smaller volcanoes like those found on the Earth. There is also a large crack or rift on the Martian surface near area of the very large volcanoes. Marsquakes and a few small eruptions are occurring, but geologically Mars is a dying world.

Several hundred long, winding channels exist on Mars, looking like dried up river channels. These are evidence for a planet with water at one time. There is some evidence that the water once responsible for the channels may now be locked in residual polar caps buried under two large carbon dioxide frost caps. The atmosphere of Mars was found to consist of 95% carbon dioxide, 2 to 3% nitrogen, 1 to 2% argon, and tiny traces of oxygen and water vapor.



Mars is the fourth planet from the Sun named for the god of war, and one of the most prominent and worshiped gods. In early **Roman** history he was a god of spring, growth in nature, **fertility**, and the protector of cattle. Mars is commonly referred to as the Red Planet. The rocks, soil and sky have a red or pink **hue**. The distinct red color was observed by stargazers throughout history.

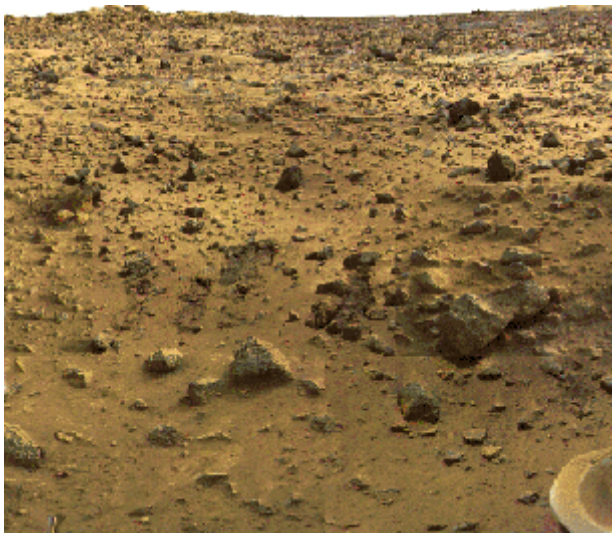
Before space exploration, Mars was considered the best candidate for having **extraterrestrial** life. Astronomers thought they saw straight lines criss-crossing its surface. This led to the popular belief that irrigation canals on the planet had been constructed by intelligent beings. In 1938, when Orson Welles broadcasted a radio drama based on the science fiction classic War of the Worlds by H.G. Wells, enough people believed in the tale of invading Martians to cause a near panic in the United States.



Center of the Valles Marineris which is 4000 km long.

Another reason for scientists to expect life on Mars had to do with the apparent seasonal color changes on the planet's surface. This phenomenon led to speculation that conditions might support a bloom of Martian **vegetation** during the warmer months and cause plant life to become dormant during colder periods.

Samples taken from **Vikings Lander** I and 2, in 1976 were thought to have **primitive microbial fossils,** but many scientists feel that a mineral deposit is a better explanation. Earthlings desperately want to have Martians as our neighbors, so myths will continue.



Lander I photo of Candor Chasma within the Valles Marineris.

ASTEROIDS

Teacher note

Asteroids are sometimes called the minor planets, most have orbits lying between Mars and Jupiter. There are some asteroids with highly eccentric orbits that can reach as far as Mercury and Saturn.

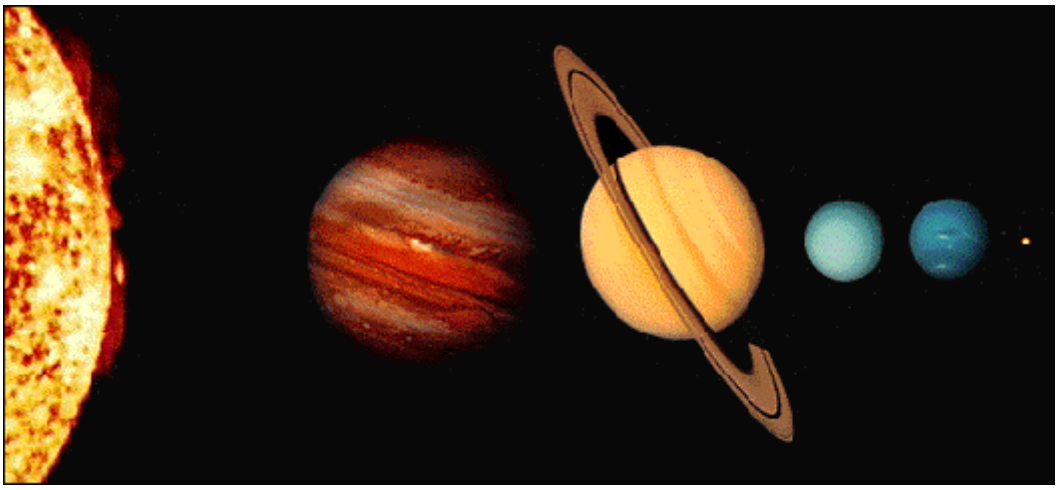
Asteroids revolve around the Sun in the same direction. Some of the asteroids may have been pulled away from their orbit, as some have very eccentric orbits. The largest asteroid is about 1000 km in diameter.

There are about 4000 plus asteroids in a 400 mile wide belts. Bits of asteroids that fall to Earth are called meteorites. There are two classifications of meteorites. Stony or chrondrite meteorites and iron rich meteorites.

In the 1766 a formula was developed that gives the approximate mean distances of the known planets from the Sun. This is known as **Bode's Law**. However there was an apparent gap in the series between the distances of Mars and Jupiter. It was thought there was a missing planet. In 1801 **Ceres** was discovered and thought to be the missing planet. But this small planet was only 770 km in diameter. Then in 1802, Pallas was discovered, another small planet. Juno was discovered in 1804, Vesta in 1807, and Astraea in 1845. Thousands of small orbits were found in a similar orbit. These minor planets are called **asteroids**. There are two ways in which asteroids may have developed. They were either a planet that never developed or a planet that broke up.

Asteroid Ida with a small moon called Dactyl was identified by the Galileo Spacecraft in 1993.

OUTER PLANETS



The outer planets are composed mainly on the 4 **gas giants** of Jupiter, Saturn, Uranus, and Neptune. Pluto, although considered a terrestrial planet is part of the outer planets, being the most remote. Except for Pluto, these gas giants all rotate on their axis within hours! They also have rings and many moons.

There as been speculation that there is a tenth planet. Theoretically it is possible, but to find such an object is still underway and very difficult. You never know what they will find!

JUPITER

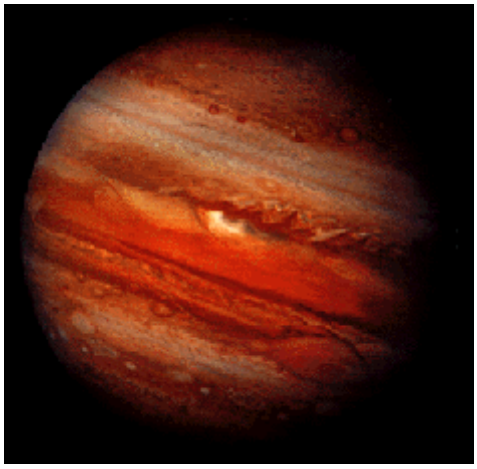
Teacher note

Jupiter is the most massive planet. If Jupiter was about 3 times as massive it would have had enough pressure and temperature in its center to set off nuclear fusion and would have been a star. The temperature is hot enough that there is no solid surface under the atmosphere, only a gradual transition from gas to liquid. The pressure and temperature are so high that the liquid becomes metallic.

Jupiter's atmosphere contains trace amounts of water, ammonia, methane and other organic (carbon) compounds. The winds on Jupiter move in parallel jets to the equator, both west and eastward. The latitudes correlate with positions of broad, alternately colored bands of orange brown and whitish clouds. The differences in cloud coloration may be due to gas rising in some bands and descending in others.

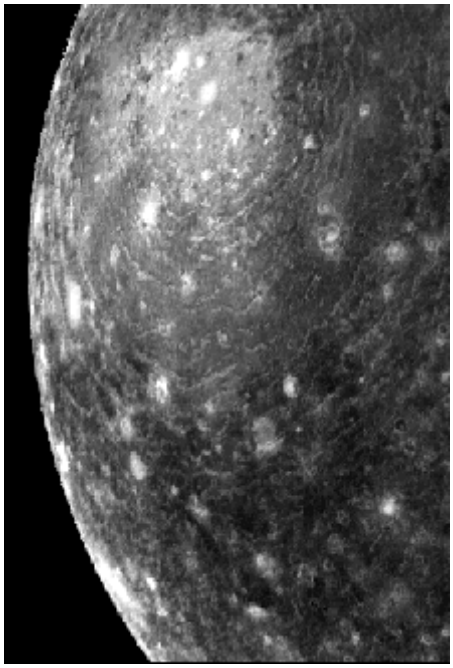
Jupiter's rings are very diffuse and composed of particles that are only a few microns.There are currently 16 moons of Jupiter ranging in size from 20 km to the largest at 5276 km (Ganymede). The other larger moons include Europa, Callisto, and Io which has active sulfurous volcanoes.

Jupiter is the fifth planet from the Sun and is the largest one in the Solar System. If Jupiter were hollow, more than one thousand Earths could fit inside. It also contains more matter than all of the other planets combined. This giant of a planet rotates on its axis every 10 hours, which means that it appears to us as spinning out of control. Imagine, the Earth rotates on its axis every 24 hours.....every 10 hours means a ride faster than any roller coaster known to humans (over 2500 miles per hour).



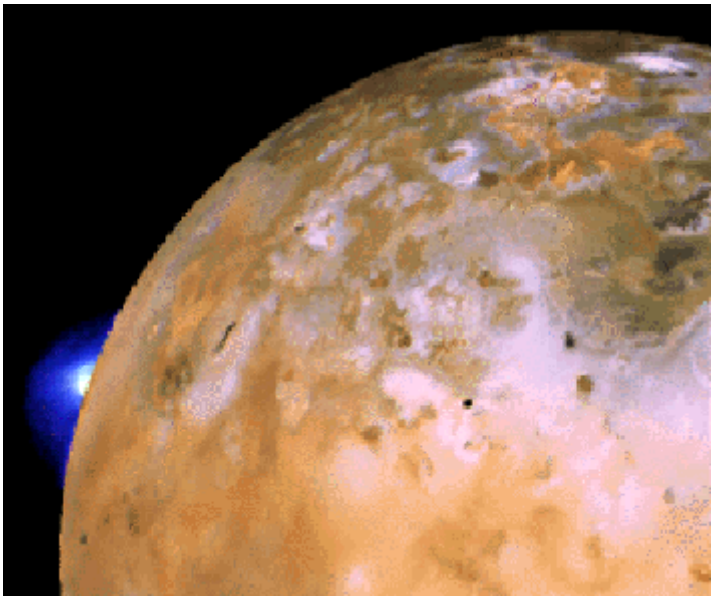
Jupiter is named for the supreme god of the ancient Romans. This name refers not only to his rulership over the universe, but also to his function as the god of the state who distributes laws and controls light and the sky.

A human **probe** cannot land on the surface of Jupiter. The swirling, turbulent atmosphere grades into a gaseous surface, getting increasingly solid as the probe would aimlessly fall into Jupiter. The solid portion of Jupiter is thought to be in a melted state of metal, so the probe would **disintegrate**, before any data could be obtained.



Jupiter radiates nearly twice as much heat as it receives from the Sun. Satellites that formed nearer to the planet are terrestrial like, similar to our Moon. Galileo discovered them in 1610 and hence they are sometimes referred to as the **Galilean moons**. In addition to the Galilean moons, Jupiter has several smaller satellites and rings.

Jupiter is almost a world into its own, with just a little more helium and hydrogen it might have been its own solar system.



SATURN

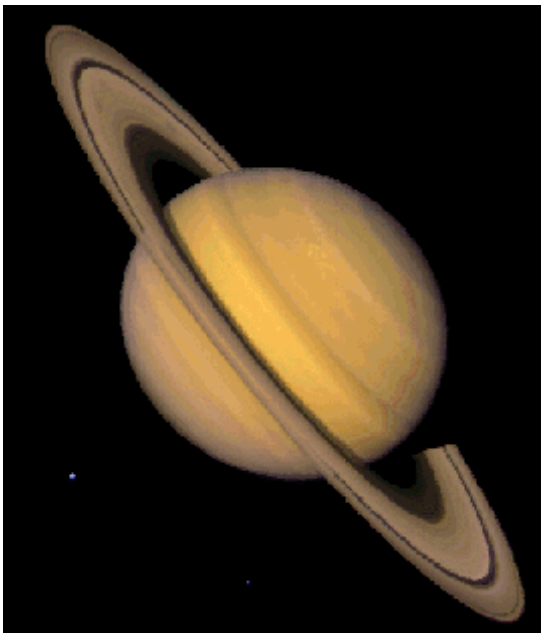
Which planet is noted for its rings?

Teacher note

Saturn appears as a light yellow and gray banded oblate spheroid with a ring system. Saturn is characterized by large size, low density and corresponding extensive atmosphere. Below the thin cloud layer is an extensive, clear hydrogen-helium atmosphere. The ratio of hydrogen to helium decreases with depth. The gas density gradually increases downward and the gas transforms into a liquid. Further down the pressures increase and the hydrogen become metallic. A small core of silicate material probably exists at the center. The atmosphere is characterized by easterly and westerly jet streams that can reach a speed of 480 m/sec. One northern hemisphere feature called the Great White Spot is apparently an upwelling of ammonia rich materials which crystallizes to produce the white color. Traces of methane, ethane, phosphine, and acetylene also exist in the atmosphere.

Saturn has a strong magnetic field. Saturn's field traps charged particles coming from the solar winds. These particles move along the magnetic field but are absorbed by satellite and ring particles.

Titan is the largest moon at 5140 km which has a thick, haze filled nitrogen



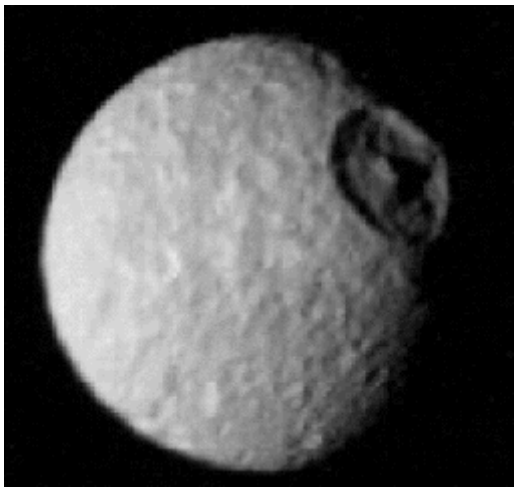
Voyager 2, in 1981 took this picture of Saturn and 2 of its moons, Rhea and Dione

Saturn is the sixth planet from the Sun and is the second largest in the solar system. Saturn is visibly flattened at the poles, a result of the very fast rotation of the planet on its axis. Its day is 10 hours, 39 minutes long, which is similar to Jupiter. The giant planets are really on the go.

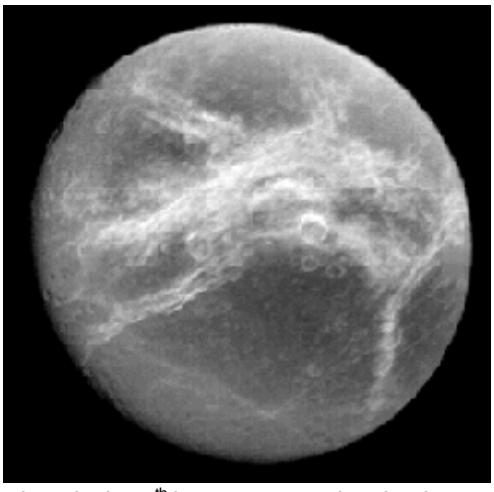
The atmosphere is primarily composed of **hydrogen** with small amounts of **helium** and **methane**. Saturn's density is less than water, which means that in the unlikely event that a large enough ocean could be found, Saturn would float in it. The wind blows at high speeds on Saturn. Near the equator, it reaches **velocities** of 1,100 miles an hour.

Saturn's ring system makes the planet one of the most beautiful objects in the solar system. Saturn's white rings were first seen by Galileo in 1610. The rings may be debris from satellites or comets broken apart by tidal forces. Saturn has the most extensive satellite system in the Solar System. More than 20 bodies orbiting around Saturn have been identified and 6 can be easily seen through the telescope.

Saturn is named for the Roman god of agriculture concerned with the sowing of the seeds. He is regarded as the father of Jupiter. Jupiter supposedly chased him away and he was taken in by the god Janus in Latium where he introduced agriculture and wine making. This event heralded a period of peace, happiness and prosperity, the Golden Age. Since Saturn was the god of farmers, the beginning of winter was a large feast to celebrate the end of the harvest. The biggest feast in his honor was the Saturnalia which became the biggest influence in the inception of today's Christmas-New Year holidays. Saturday was named for Saturn.



Mimas, a 394 km diameter moon has a larger crater on the top



Dione is the 4th larges moon, showing icy fluids that broke through the crust

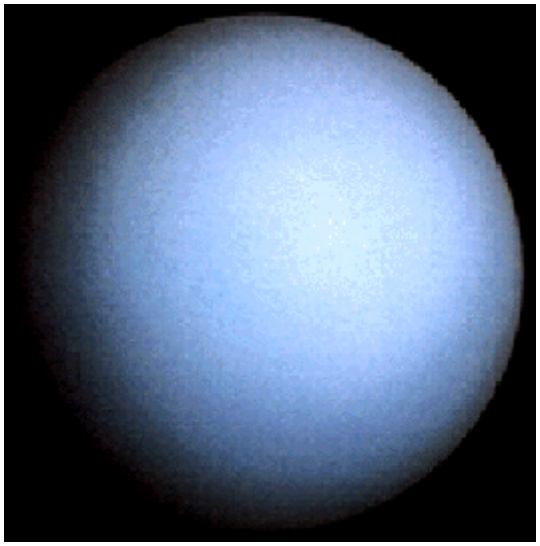
URANUS

Teacher note

In Greek mythology, Uranus (Ouranos) is the personification of the sky and the son and mate of Gaia. Uranus was jealous of the future power of his children and feared he would lose his rulership to them. He threw his children in the underworld to prevent this. At the instigation of Gaia, her son Cronus castrated his father and dethroned him. When Uranus' blood fell upon the Earth (Gaia), the Erinyes (the goddesses of vengeance) and the Gigantes (giants) sprang forth, among many other divinities.

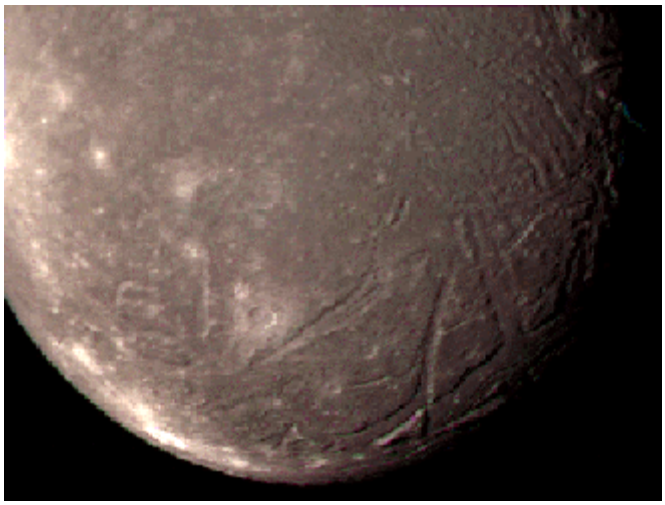
Uranus has 15 moons, nine of them have diameters between 40 and 80 kilometers and are located closest to Uranus. The other 6 are much larger and are the only moons that have been photographed. The moons are 1985U1, which is 160 kilometers across, Miranda, Ariel, Umbriel, Titania and Oberon. Miranda displays one of the most bizarre geological features seen in the Solar System.

Uranus was discovered in 1781 by Sir William Herschel, seeing a **featureless**, bluish, green disk in his telescope. The atmosphere is mainly hydrogen with a minor percentage helium. A thin **methane ice clouds** was detected by **Voyager 2.** Deep within Uranus exists a **superheated** water ocean, perhaps 10,000 km deep which contains large concentrations of **ionized chemicals**. It is from this ocean that the **magnetic field** may originate. Beneath this ionic ocean is believed to be a core of **molten** rocky materials. Unlike the other gas giant there is no evidence of any significant internal heat source.



Uranus

Uranus also has rings! Observations have indicated the presences of 10 narrow rings and one broad ring, in addition to 100 or more **ringlets**.



Ariel, a moon of Uranus with many craters.

NEPTUNE

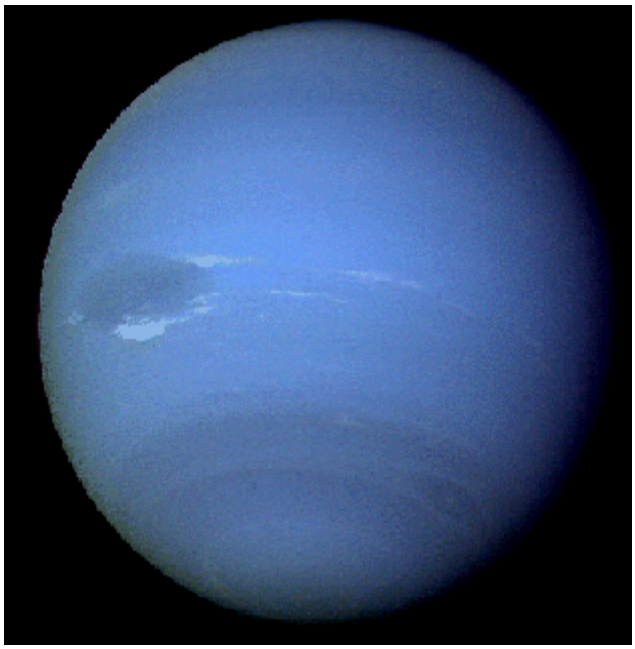
Teacher note

Neptune was discovered in 1845. Atmospheric features include a large dark storm system named the Great Dark Spot, and many other smaller dark storm systems with bright core of feathery clouds. The weather on Neptune may be as dynamic and changeable os the Earth's. The atmosphere consists mainly of hydrogen and helium, but about 3% of the atmosphere is methane. Cirrus clouds are made of crystals of methane.

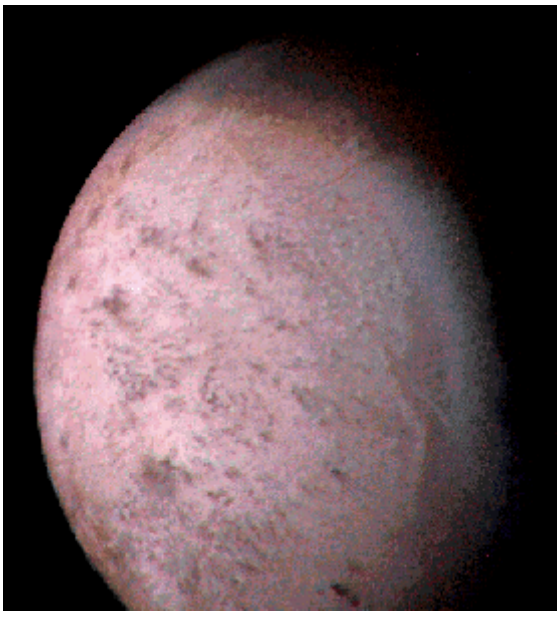
Neptune, Son of Saturn, and brother to Jupiter and Pluto, god of the sea. Usually shown carrying a **trident** and rising from the sea. The god of the sea among the Romans.

Neptune's blue atmosphere has storm systems similar of those in Jupiter's atmosphere. **Optically** thin methane ice cloud exists. Neptune's magnetic field is highly titled and offset from the planet's center, it rotates once every 16.11 hours. There are 2 narrow and 2 broad rings that circle the planet.

Neptune has 8 moons with Triton being the largest with methane and nitrogen at their polar caps and a thin atmosphere.



1989 Voyager 2 photo



Triton, a moon of Neptune

PLUTO

Teacher note

Pluto the god of the dead, the abductor, and later, the husband of Proserpine. Pluto assisted his two brothers, Jupiter and Neptune, in overthrowing their father, Saturn. They then divided the world among themselves, with Jupiter choosing the Earth and the heavens as his realm, Neptune becoming the ruler of the sea, and Pluto receiving the lower world as his kingdom. He was originally considered a fierce and unyielding god, deaf to prayers and unappeased by sacrifices. Later the belief arose in which the milder and more beneficent aspects of the god were stressed. He was believed to bless the Earth, such as mineral wealth and crops. He was the Latin counterpart of the Greek god Hades.

Because Pluto has not yet been visited by any spacecraft, it remains an unknown planet. Due to its great distance from the sun, Pluto's surface is believed to reach temperatures as low as -240/C (-400/F). From Pluto's surface, the Sun appears as only

Pluto was discovered by Clyde W. Tombaugh in 1930. It was named for the Pluto, the brother of Jupiter and Neptune. Pluto's orbit is highly **eccentric**. This unusual orbit brings Pluto inside the orbit of the planet Neptune during its close approach to the Sun, as for example during the current period between January, 1979 and March 15, 1999. The actual orbital paths do not cross because Pluto's orbit is more **inclined**.

Pluto has one grayish satellite called **Charon** discovered in 1978. Charon complete one revolution in about 6 days, the same as Pluto's rotation period. The two objects (Pluto and Charon) may be relics of the early days of the Solar System, or may be a captured planet from another planetary system. Information on Pluto is still incomplete.

Pluto with its moon Charon

EARTH SCIENCES - SOLAR SYSTEM

Lesson 3 - PLANETARY INFORMATION

MATERIALS:
labsheet
Internet
reference material

Objective: Students research information on the different planets.

PLANETARY INFORMATION

Teacher note

Use the lab sheet and have the students search the internet or reference books to try and determine the information to place in their data chart. We hightly recommend: http://www.nasa.org and http://www.seds.org . Use appropriate search engines.

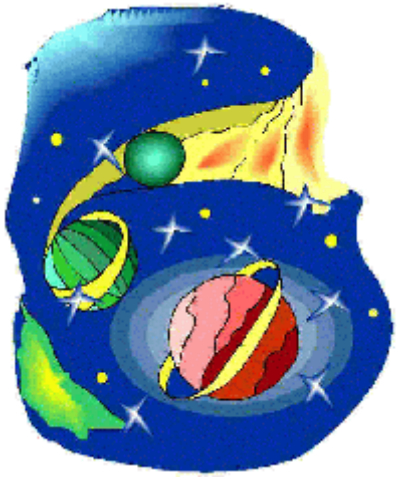
NOTE: Some of the data will change with more observations.

DATA CHART I.

planet	diameter in km	low temp C°	high temp C°	distance from Sun in km	# of satellites
MERCURY	4,880	-170	+400	$.0579 \times 10^9$	0
VENUS	12,100		+440	$.1082 \times 10^9$	0
EARTH	12,740	-53	+50	$.1496 \times 10^9$	1
MARS	6,794	-127	-29	$.2279 \times 10^9$	2
JUPITER	143,200	-150		$.7783 \times 10^9$	16
SATURN	120,000		-200	1.427×10^9	20
URANUS	51,800	?	-214	2.87×10^9	15
NEPTUNE	49,500	?	-218	4.497×10^9	8
PLUTO	2,500		-330?	5.9×10^9	0

The planets are fascinating, but there is so much information! You are probably not all that interested about planets, but there may be a day that you want to learn more information. The Internet and reference books can help you find information. Try and find a site or book that can help you fill in the blanks on the data sheet. Get the information in metric if you can, it not state what units you found the answer in. The column labeled "Satellites" refer to the number of moons that the planet has revolving around it.

In Data II you are asked to find the rotation on its axis in days and revolution around the Sun in days. Also find the number of rings, if it has any. Your teacher might want you to find more information. But use the extra room if you find something you think is interesting.



Teacher note

DATA CHART II.

planet	mass of planet compared to Earth	tilt of axis	revolution	rotation	eccen-tricity	rings
MERCURY	.054		88 days	59 days	.21	0
VENUS	.82		224.7 days	243 days	.01	0
EARTH	1	23	365 days	24 hrs	.02	0
MARS	.11	24	687 days	24 hrs	.09	0
JUPITER	318	3	12 years	10 hrs	.05	1
SATURN	95	27	29 years	11 hrs	.06	7
URANUS	15	98	84 years	15.5 hrs	.05	10
NEPTUNE	17	50	165 years	16 hrs	.01	4
PLUTO	.9(?)		248 years	6.5 days	.25	0

FINDING INFORMATION ABOUT PLANETS
LAB

PROBLEM: How can you find information on the planets?
HYPOTHESIS: _____
PROCEDURE: Use the Internet or reference material and try to find the missing data.

DATA CHART I.

planet	diameter in km	low temp C°	high temp C°	distance from Sun in Km	# of satellites
MERCURY					
VENUS					
EARTH					
MARS					
JUPITER					
SATURN					
URANUS					
NEPTUNE					
PLUTO					

DATA CHART II.

planet	revolution	rotation	rings	other information
MERCURY				
VENUS				
EARTH				
MARS				
JUPITER				
SATURN				
URANUS				
NEPTUNE				
PLUTO				

EARTH SCIENCES - SOLAR SYSTEM

Lesson 4 - SOLAR SYSTEM CHARACTERS AND STORY TELLING

MATERIALS:
paper
drawing pencils

Objective: Students create a story using characters from the Solar System.

SOLAR SYSTEM CHARACTERS AND STORY TELLING

Teacher note

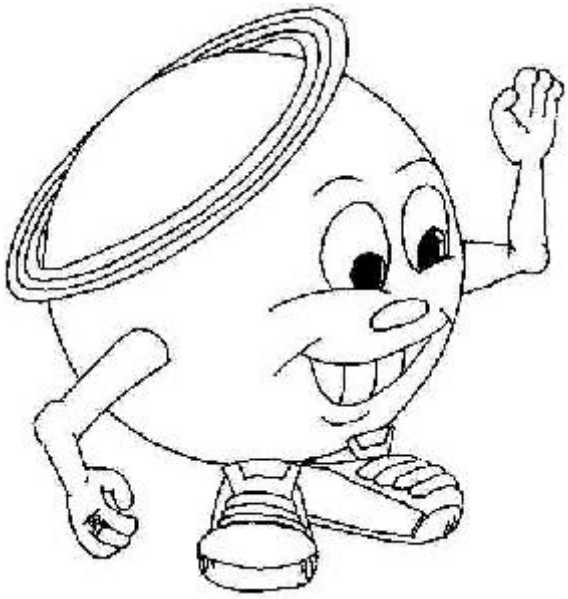
We give students a "star" if they do excellent work on their paper. The Universe symbols that we use in our everyday lives seem to be positive, mystical, or adventurous. There are everyday reminders of space around us.

Ask students to make a list of movies, television, comics or books that may have a space theme from Star Trek to Star Wars. You may want to take a poll on which of these shows are popular.

In this exercise have students use their imagination and write a short story on the "Saturn" character or you many want some of the artistically inclined students to develop their own space characters based on some of the information they have learned.

"My place in space is a gas. I twirl around with all these rings and it makes me look real cool. Help me write my story to tell other teenagers, so they remember how awesome I am. "

This is an example of Mr. Saturn's biography. Continue his story either when he was young, teenager, adult, or old age. Redraw Saturn at each of his ages. You can make a cartoon comic strip or a short story with one drawing. Use your imagination to create a story. If you like another planet better, you can create your own cartoon and story. Remember only Venus is a girl, the rest of the planets are boys.



EARTH SCIENCES - SOLAR SYSTEM

Lesson 5 - COMETS

MATERIALS:
reader

Objective: Students learn about the creation and life of a comet.

COMETS - A STORY

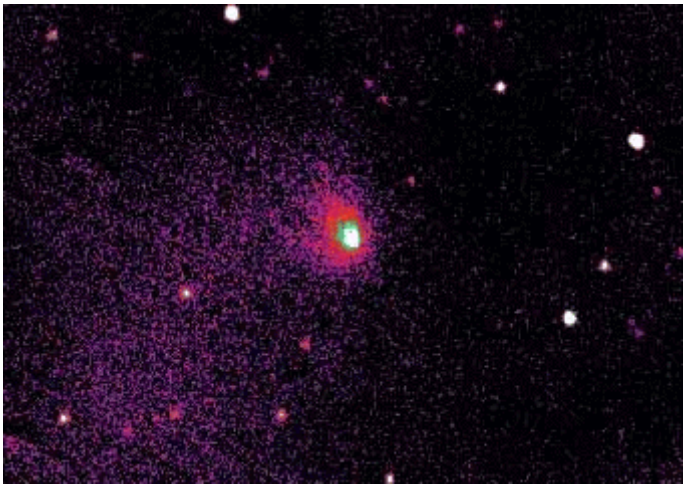
Teacher note

Comets vary in appearance but usually have a bright nucleus or head containing most of the mass and a translucent tail. They have elliptical orbits around the Sun. When far from the Sun a comet is just a collection of dust, cemented together by ice or frozen gases.

Students should read the story and then discuss with them what they learned.

Introduction

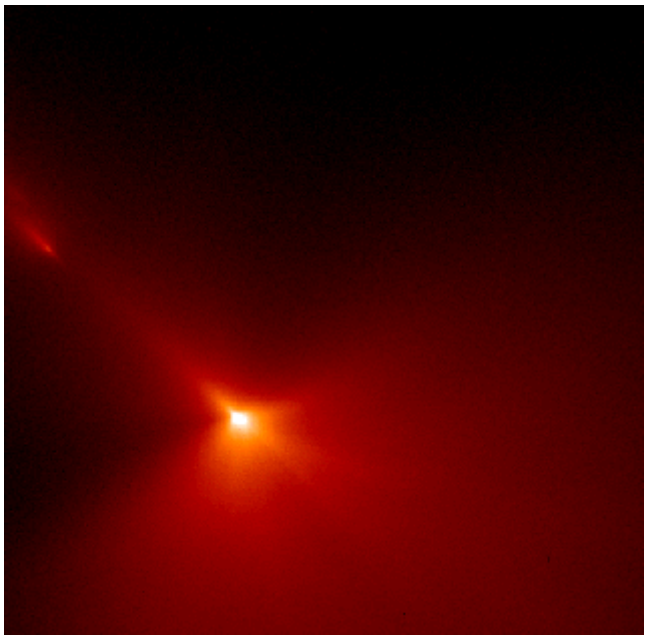
During the spring and summer of 1997, many people in the world were lucky enough to see Comet Hale-Bopp. This beautiful comet, with its two streaming tails, was visible in the night sky for many months as it sped around the Sun. It was the brightest comet to be seen in many years. During its closest approach to Earth, it was even visible during twilight.



Hale-Bopp comet in 1998 taken by Ian Griffin.

People have observed comets in the night skies for a long time. Chinese astronomers wrote of “broom stars”, or comets, almost 3000 years ago. Written and oral records from Asia, Africa, North and South America, and Europe all speak of cometary visits throughout the ages. For many peoples, comets were omens of disaster. They were blamed for wars, earthquakes, plagues, even the deaths of leaders. Early European astronomers thought that comets were a type of cloud in the Earth’s atmosphere.

What is a Comet?



Comet Hyakutake, 1996 taken by H. Weaver

We now know that comets are not omens or clouds. They are small, wandering members of our Solar System that orbit the Sun. They are interplanetary objects, traveling across the orbits of many of the planets.

Comets are often called "dirty snowballs". This is a good description, because they are composed of a mix of dust and gasses. The dust includes silicate minerals similar to the ones you have studied in early lab classes, and a variety of carbon-rich inorganic compounds. Typical gasses in comets include water ice (H_20), CO_2, and CO.

Comets are very old. Astronomers have concluded that comets formed at the same time as the Solar System, about 4.6 billion years ago. Along with asteroids (chunks of rock and metal) they are leftovers, material that was not used up in making the Sun or the planets.

Orbits

Comets travel in elliptical (oval-shaped) orbits around the sun. Comets are very fast. They move at speeds of 40 to 60 kilometers per second, which is about 230,000 to 300,000 miles per hour! Comets appear to move slowly in the sky only because they are so far away from the Earth.

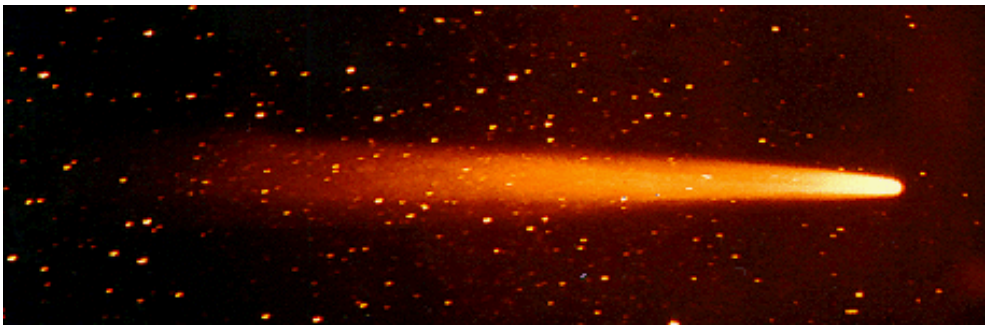
When a comet is far away from the Sun, it is very cold. The comet consists of a solid lump of dust and frozen gas. This lump is the nucleus of the comet. It may be up to 10 kilometers in width. The comet changes as it swings in closer to the Sun. It becomes active. Energy from the Sun heats the comet. This heating causes some of its gasses to vaporize, or change from a solid to gaseous state. This creates a glowing head, or coma, around the nucleus of a comet. The head may be over 100 kilometers wide. Heating also causes jets of gas to erupt on the comet' surface. These form the comet's long, streaming tails. These changes make the comet visible from the Earth.

The Tails of a Comet

The most visible and perhaps beautiful parts of a comet are its two tails: the gas tail and the dust tail. In fact, the tails gave comets their name. The word "comet" comes from the Latin words *aster kometes*, which means "long-haired star".

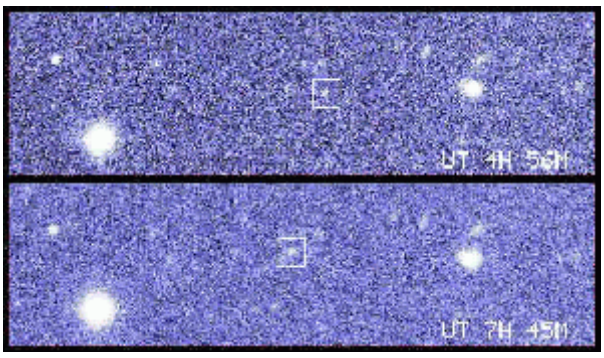
The gas tail of a comet is very straight and narrow. It is composed of **ionized gas** molecules. This tail is visible because the ionized gas molecules glow. The gas tail forms because gas molecules in the comet's head are blown outward by the solar wind. The solar wind is the fast moving cloud of plasma which constantly shoots out of the Sun in all directions. The **gas tail** thus always points away from the sun.

The **dust tail** consists of dust particles, which are also blown outward from the comet's head. This tail has a broader, more curved shape than the gas tail. The dust tail is visible because the dust particles shine in sunlight. Sunlight also forms the dust tail. The pressure of sunlight striking the dust particles literally blows them away from the head of the comet.



Tail of Halley's Comet

Where Do Comets Come From?

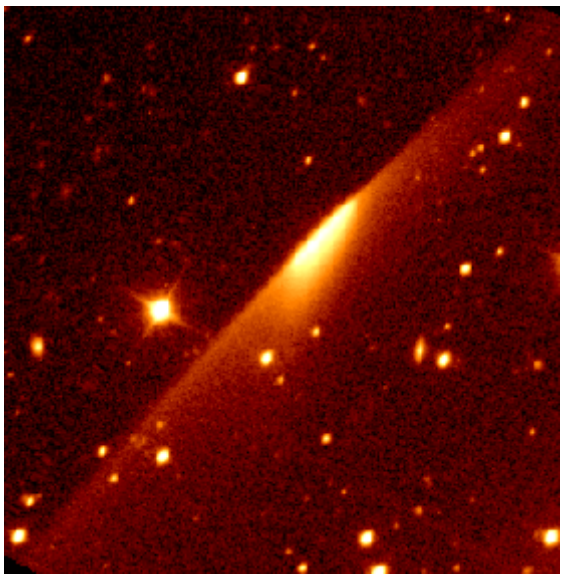


Comets have two “homes” or source areas. Most comets reside outside the Solar System, in a large spherical region called the **Oort Cloud**. It is named after Jan Oort, the Dutch astronomer who first proposed its existence. The Oort Cloud is very far away, between 5 to 8 trillion kilometers from the Sun. It probably contains trillions of comets, all of which are leftovers from the formation of the Solar System. Most comets stay in the Oort Cloud. However, when disturbed by gravity or **collisions**, a comet may drop into the Solar System, where we can see it.

The second home of comets is the **Kuiper Belt**, named after the American astronomer Gerard Kuiper. The Kuiper Belt is a ring of comets within the Solar System, between the orbits of Neptune and Pluto. Like the Oort Cloud, Kuiper Belt comets are remnants from the forming Solar System. They travel in toward the Sun when disturbed by the gravity of nearby planets. Halley’s Comet, which is visible from Earth about every 75 years, and Comet Hale-Bopp are both Kuiper Belt comets.

Collisions

As comets come into the Solar System from the Oort Cloud or the Kuiper Belt, they cross the orbits of the planets. Once in a while, a planet and a comet **collide**. We recently witnessed the results of one such event: the collision of Comet Shoemaker-Levy 9 with Jupiter.



Comet Shoemaker-Levy 9

This comet was found in 1993 by the team of Gene and Carolyn Shoemaker and David Levy. While it appeared as a streak on the first photographs, later pictures revealed that the comet was broken into 20 pieces, probably by coming too close to Jupiter in the past. In July of 1994, all of the pieces of Shoemaker-Levy 9 hit Jupiter. The **impacts** caused explosive plumes of gas to shoot many thousands of kilometers into space above Jupiter. Large dark "scars" the size of the Earth also appeared in Jupiter’s atmosphere. Many of them were still visible month later. As of 1999, small bits of debris thrown up by the impact continue to hit the planet.

Finding Comets

Astronomers discover about a dozen comets every year. Some of these are new comets that have never been seen before. Others are rediscoveries, comets that were found in the past and then "lost" because no one was keeping track of them. Astronomers have found a total of over 2,000 comets.

When they are far from the Sun, comets are discovered by looking at photographs taken through telescopes. They show up as streaks or as dots that move on different photographs. When a new comet is discovered, it is often named after the people who found it. For example, Comet Hale-Bopp was named after the two astronomers who discovered it, Alan Hale and Thomas Bopp.

Many comets are found by amateur astronomers, working with their own homemade telescopes. Maybe you will find a comet someday, and it will end up having your name!

Earth Science- Solar System - Unit Test

Part 1. Definitions Match the number of the term or concept in Column 1 with the letter of the correct definition in Column 2.

Column 1	Column 2
1. Egyptians	a dirty snowball
2. Gas giants	b. Mercury, Venus, Earth, Mars, Pluto
3. Venus	c. satellite of the Earth
4. Asteroids	d. ancient civilization that recorded sunrises and sunsets
5. Moon	e. 10 hr 39 min
6. Rotation of Jupiter	f. Rotates clockwise, known as morning and evening star
7. Copernicus	g. minor planets between Jupiter and Mars
8. Rotation of Earth	h. the planets revolve around the Sun
9. Comet	i. 24 hours
10. Terrestrial planets	j. Jupiter, Saturn, Neptune, Uranus

Part 2. Multiple Choice Choose the best answer to complete each statement.

1. Ptolemy was a Greek philosopher who proposed:
    a. the Sun was the center of the Universe
    b. the Earth was the center of the Universe
    c. the Sun and other stars revolve around the Earth
    d. the Earth revolves around the Sun

2. The following person was not involved in early astronomical thought?
    a. Galileo
    b. Da Vinci
    c. Newton
    d. Kepler

3. Which is not an inner planet?
    a. Jupiter
    b. Mercury
    c. Earth
    d. Venus

4. Which is an outer planet?
    a. Mars
    b. Venus
    c. Neptune
    d. Earth

5. Which is not a gas found in the Saturn atmosphere?
    a. hydrogen
    b. helium
    c. methane
    d. oxygen

6. The moons of Jupiter are called?
    a. Jupiter moons
    b. Galilean moons
    c Green moons
    d. none of the above

7. Io is a moon of?
    a. Saturn
    b. Neptune
    c. Jupiter
    d. Earth

8. Which person proposed that the Sun is the central point in which the planets revolve around them?
    a. Ptolemy
    b. Aristole
    c. Copernicus
    d. Newton

9. Which scientist proposed the laws of motion that applies throughout the Universe?
    a. Sir Isaac Newton
    b. Galileo
    c. Copernicus
    d. Ptolemy

10. Pluto is considered?
    a. a terrestrial planet
    b. a gas planet
    c. an inner planet
    d. a moon

ANSWERS:

PART I.

1. D
2. J
3. F
4. G
5. C
6. E
7. H
8. I
9. A
10. B

PART II.

1. C
2. B
3. A
4. C
5. D
6. B
7. C
8. C
9. D
10. A