

ELEMENTARY SCIENCE PROGRAM
MATH, SCIENCE & TECHNOLOGY EDUCATION

A Collection of Learning Experiences on
SOLAR SYSTEM



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SOLAR SYSTEM

GRADES 5/6

Unit Overview

This unit provides students with the opportunity to research the planetary bodies of our solar system, create models of our solar system, and investigate relationships between the planetary bodies of our solar system. The science skills emphasized in the solar system kit are discussing, observing, creating models, comparing, and predicting.

Scheduling

This unit may take from five to ten weeks to complete depending upon the goals of the teacher and interests of the students. Use of the section included in this manual called More Ideas may extend the time span of this kit.

Materials to be obtained locally:

Please make **one** student activity book for **each** student.

folders	notebook
fan or blow dryer	glue
paper (21.5 cm x 27.5 or 8 1/2 x 11)	research materials (books, video, internet)
tape	pencils
metric ruler	45,60, or 75 watt bulb
lamp w/no shade	chart paper
felt tip markers	modeling clay (optional)
large piece cardboard (optional)	mini-marshmallows (Kix cereal)
straw (optional)	meter stick
calculators	construction paper (white, red, orange,yellow)
tape	extension cord
index cards	newspaper
photocopy paper box lid	overhead transparencies/pens
scissors	
water	

Caution

Remind students to wash their hands after handling any of the materials in the kit.

About the Format

Each learning experience is numbered and titled. Under each title is the objective for the learning experience. Each learning experience page has two columns. The column on the left side of the page lists materials, preparations, basic skills processes, evaluation strategy, and vocabulary. The evaluation strategy is for the teacher to use when judging the student's understanding of the learning experience.

The right column begins with a "Focus Question" which is typed in italicized print. The purpose of the "Focus Question" is to guide the teacher's instruction toward the main idea of the

learning experience. The “Focus Question” is not to be answered by the students. The learning experience includes direction for students, illustrations, and discussion questions. These discussion questions can be used as a basis for class interaction.

A **Student Assessment** has been included in the **Teacher’s Manual** and the **Student Activity Manual**. If you do not want the students to have the assessment beforehand, remove it from the **Student Activity Manual** before printing a class set of the student manuals.

Background Information

Gravity is the force of attraction between two objects depending upon the mass of the two objects and on the distance the two objects are from each other. The more massive the objects are the more gravitational pull they have for each other, therefore, the greater the force of attraction. Sir Isaac Newton discovered that a force is required to change the speed or direction of movement of an object. Some objects require more force to move than others. All planets in our solar system have a gravitational pull that they exert on other objects and other planets and moons. When comparing the strength of the gravitational pull of the sun, planets, and moons, their gravitational pull differs because of their difference in mass and density. For example, the moon has less mass than the Earth, it has a smaller gravitational effect on the Earth. On the surface of the moon, the level of gravity is only about one-sixth of what it is on Earth. A person who weighs 100 pounds on Earth would only weigh 17 pounds if they stood on the moon.

The effect of gravity extends from the center of each object, indefinitely into space in all directions. It is the sun’s gravity that keeps the Earth in its orbit, and it is the Earth’s gravity keeping the moon in its orbit. Earth’s gravity also keeps the Earth’s atmosphere, oceans, and inhabitants from drifting out into space. Humans are not conscious of the sun’s gravity pulling on them because it is so small at this distance. The moon has gravity, and it too pulls on the Earth, but it does not have enough gravity to become the central object. We are also not aware of lunar gravity pulling on the Earth, but it is lunar gravity that causes the tides.

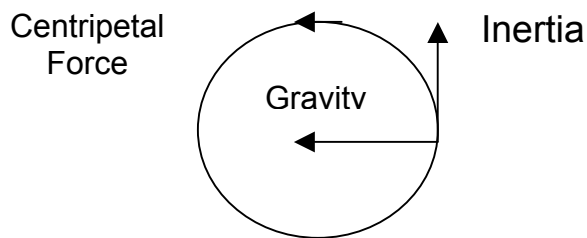
Mass is the measurement of the amount of matter in an object. Mass is measured by comparing the object’s mass with a standard mass. Therefore, some sort of balance scale is needed to measure mass. It is important that students understand that mass does not equal weight. **Weight** is the measure of gravitational pull on an object. Therefore, weight will vary with gravitational force. If you measure the weight of an object on the Earth and then measure the weight of the same object on the moon, the object would weigh less due to the fact that the force of gravity is different on the moon versus the Earth. However, the mass of the object would be the same on the Earth and on the moon because the amount of matter in the object remains constant.

Inertia and Centripetal Force

A passenger rounding a corner in a car seems to be pushed to the outside of the curve. This is due to your body’s inertia trying to keep you moving in a straight line. The car is curving around in front of you and intercepting you in your straight path. The car door pushes you towards the center of the curve and makes you change direction

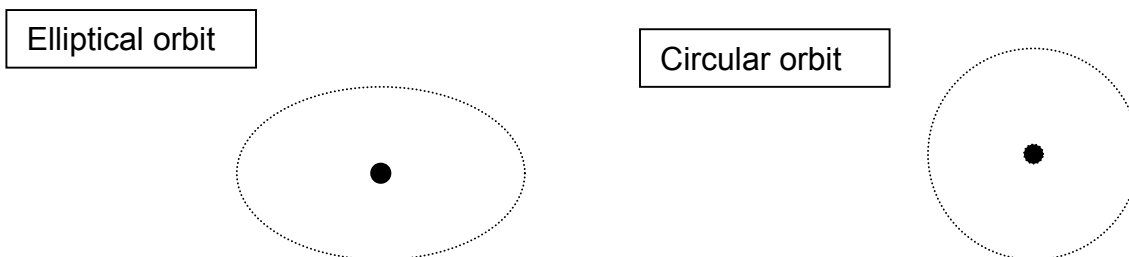
The motion of any body in orbit is a balance between gravitational attraction and the tendency of the moving body to travel in a straight line off into space. The force that pulls toward the center and causes an object to follow a circular path is called a **centripetal force**. When you swing a ball from the end of a piece of string in a circular motion, you must pull on the string to

keep it in motion, exerting a centripetal force. A weight on the opposite end of the string can act as the gravitational force that provides the centripetal force needed to keep the ball in a circular motion. When you let go of the string, the ball travels in a straight path but at a right angle to the string at the moment of release. Part of Newton's first law of motion states that an object in motion will move in a straight line unless acted on by an unbalance force. We call this inertia. In the case of the ball on a string, your inward pull on the string is the unbalance force that keeps the ball traveling in a circle instead of a straight line. Upon release, the ball travels away in a straight line in the exact direction it was traveling at that very moment it was released. The moon is not on a string, but, because of the centripetal force, Earth's gravity pulling on the moon, gravity keeps pulling the moon toward the center of the Earth creating a circular path. In the case of a satellite in space, the launch vehicle that carried it up to orbit aimed it in a direction parallel to the Earth's surface. According to Newton's first law, the satellite will travel in a straight line. Then Earth's gravity acts as an unbalance force, pulling on the satellite and causing the satellite to follow a circular path.



Planetary orbits are generally elliptical, therefore, the moon moves in an elliptical path around the Earth.

Most planets and moons orbit in an ellipse, rather than a circular orbit.



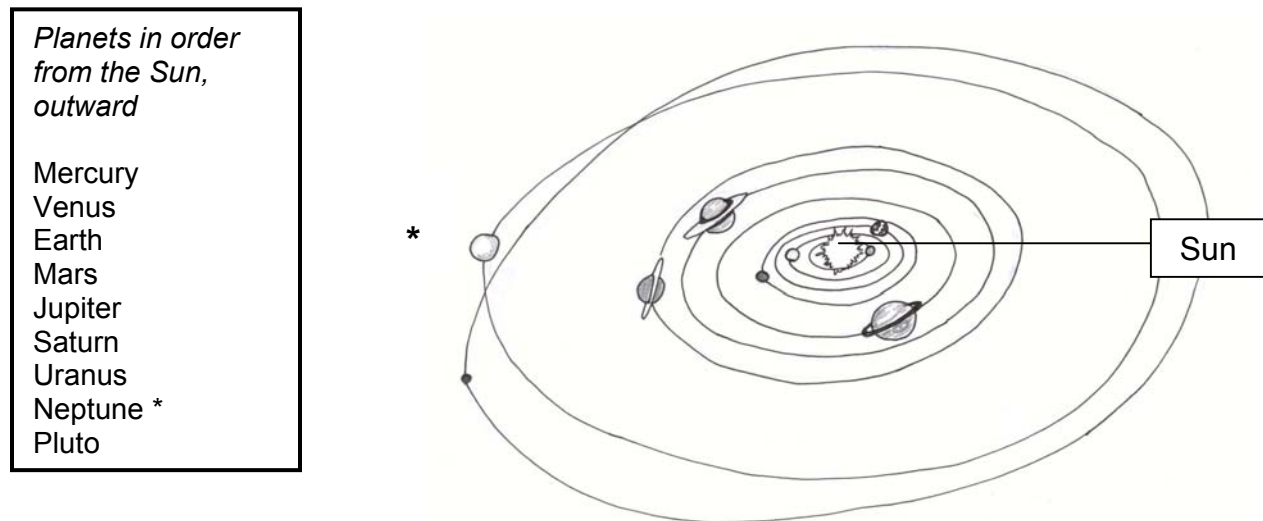
Orbits, Rotational Period, Revolutionary Period

Some objects get caught in a **temporary orbit**. The sun's gravity pulls them in, and they orbit around the sun but leave again. Comets sometimes get pulled into our solar system this way. When this happens, the larger body's gravity increases the speed of the smaller body. Sometimes NASA uses this type of orbit to increase the speed of spacecraft, moving them around a planet like a slingshot and sending them off in a different direction at a quicker pace to save time and fuel.

A "**period**" is defined as "the completion of a cycle, a series of events, or a single action." The **rotational period** is the amount of time required for an object to complete one turn, or rotate once on its axis. On Earth, we call this cycle a "day". The Earth's day is exactly 23 hours, 56 minutes, 4.2 seconds. The moon is much slower; it takes 655.728 hours or 27.322 days to

complete one turn on its axis. In addition, the bodies in our solar system move around, or orbit other bodies. Planets orbit the sun and moons orbit planets. The amount of time required for a celestial body to complete one orbit around another body is referred to as an “**orbital period**” or “**revolutionary period**”. On Earth, our orbital period around the sun is called a year. Our year is 365.256 days. On Mars, it takes 686.98 Earth days to complete one orbit around the sun. Since the moon’s orbit centers on the Earth, rather than the sun, it would be misleading to think of the moon’s orbit as a year. The cycle of the moon orbiting the Earth corresponds to our system of calendar “months”. It takes 27.322 days for the moon to orbit the Earth. It is exactly the same as its rotational period.

Orbit of Planets Around the Sun



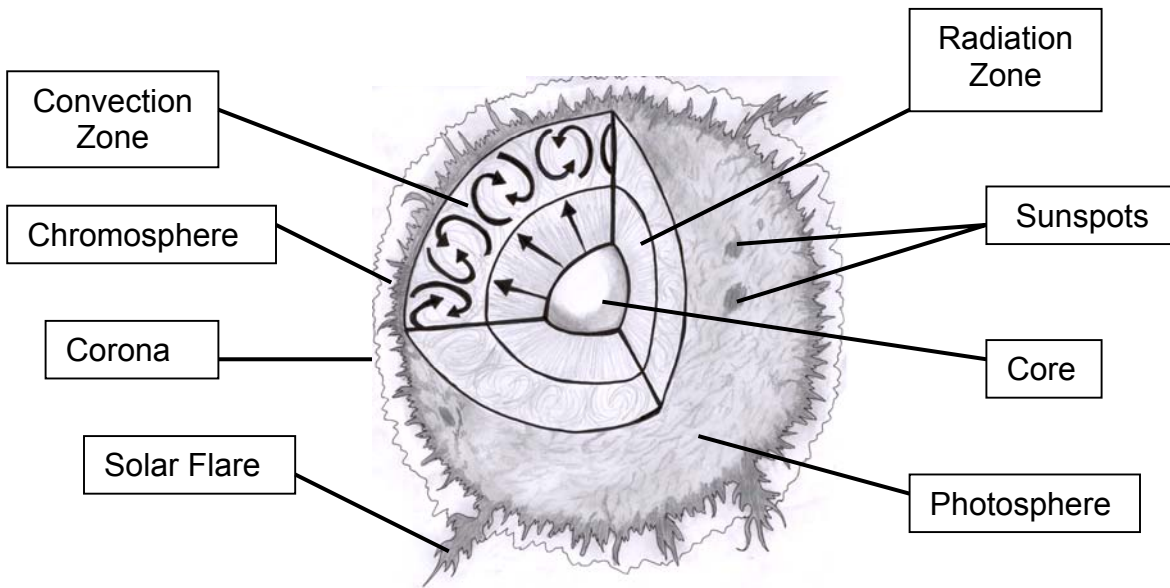
Note: Neptune and Pluto switch at times. *

Our Galaxy – The Milky Way

The Earth is one of the nine planets revolving around the sun, our closest star. Our sun is only one of the more than 100 billion stars in the Milky Way Galaxy held together by the force of gravity. The Milky Way Galaxy is shaped like a huge disk with a spherical bulge at its center. Our galaxy is revolving around its center. It takes 200 million years to complete one revolution. Galaxies come in three basic shapes: spiral, elliptical, and irregular. The Milky Way Galaxy is an open spiral galaxy with spiral arms wrapped around a nucleus. There are more than 100 billion galaxies in the universe.

The Sun

The sun is approximately 333,400 times larger than Earth, and contains 99.86% of the mass of the entire solar system. Its density is about 160 times that of water. The total energy radiated is 383 billion trillion kilowatts/second, which is equal to 100 billion tons of dynamite exploding each second.



Core

The center of the sun is a nuclear “furnace” where hydrogen atoms are fusing to form helium atoms, which release a tremendous amount of energy. The temperature is an estimated 14 million degrees C (27 million degrees F), which is the hottest layer of the sun. The pressure is 200 billion times the pressure at the Earth’s surface. Due to this pressure, the sun’s core is ten times more dense than iron.

Radiation zone

This is the sun’s thickest layer. Energy leaves the core as gamma rays are absorbed and emitted millions of times by hydrogen and other atoms. Energy is transformed into X-rays, ultraviolet light, and visible light. It takes millions of years for the energy from the sun’s core to make its way through this layer, but once it does it only takes eight minutes to reach the Earth’s surface.

Convection zone

This layer extends within 100 miles of the sun’s surface. Energy reaches the surface much as heat reaches the top of a pot of boiling water as bubbles of hot gases rise. The rise and fall of bubbling gases keeps energy constantly moving to the surface.

Photosphere

The photosphere is the surface of the sun, and it is the layer we can see. This surface is not smooth. Its appearance is known as **granulation** caused by the “bubbling” motions inside the sun. At about 6100 degrees C (11,000 degrees F), it is the inner layer of the sun’s atmosphere. Most of the light and other energy that reaches the planets are released from this layer. It is made up of columns of rising gas called **granular cells**. Sunspots form on the photosphere.

Chromosphere

Larger cells of rising gas, called **supergranular cells**, make up this middle layer of the sun's atmosphere. It is a thin, layer of gas approximately 3000 km thick. It is the site of gas eruptions, such as flares and spicules. **Spicules** are explosions of gas that can shoot 9600 km into the outer atmosphere. It is a thin layer of gas, about 60,000 degrees C (180,000 degrees F), which we normally cannot see because of the photosphere's brightness. During a total eclipse, however, we are able to see the thick, pink band of the chromosphere.

Corona

The corona is the outermost layer of the sun's atmosphere, and its temperature measures up to 2.7 million degrees C (5 million degrees F). It extends a few million miles from the sun before merging with interplanetary space. During a total eclipse, not only can we see the chromosphere, but we can also see the white corona. Solar material escapes from holes in the corona and creates the solar wind. The **solar wind** is a stream of energized particles that blow outward through the solar system. At the maximum of the eleven-year sunspot cycle, the corona appears circular, while at the sunspot minimum it is noticeably elongated.

Sunspots

Magnetic fields within the sun slow down the radiation of heat in some areas, causing **sunspots**, which are dark, slightly cooler areas on the surface of the sun. They average about five times the size of the Earth and come and go on an approximate 11-year cycle. While the spots are relatively cool, they are associated with activity that increases the overall energy coming from the sun.

Solar flares

The sun frequently releases plumes of energy or bursts of solar wind. These **solar flares** are the explosions of energy from the sun that send atomic particles, X-rays, and other energy hurling outward. Some of the particles and radiation reach the Earth's atmosphere. Effects on the Earth range from interference with some radio transmissions to geomagnetic storms that can knock out power systems in the North. They also cause colorful auroras known as the northern and southern lights. **Auroras** are glowing rays or bands of light that shimmer of red, yellow, or green. They are more common toward the Earth's poles. Since magnetic energy is involved with the solar flares, the flares are usually associated with sunspot groups where the strongest magnetic fields occur.

Sundials

The earliest and simplest form of the sundial is the shadow stick. The time of day is indicated by the length and position of the stick's shadow. The **gnomon** is the technical name for the shadow stick. The shadow of the gnomon rotates clockwise. The shadow is the shortest when the sun is directly in the south, defining local noon. As early as 3500 BC, the Egyptians began building slender four-sided obelisks which served as timepieces. The moving shadow of the obelisk formed a type of sundial, and markers around the base separated the day into divisions as well as indicating the longest and shortest days of the year. If the sun rose and set at the same time and spot on the horizon everyday, sundials would be a fairly accurate clock. However, the sun's path through the sky changes every day because of the Earth's axis is tilted. On Earth's yearly trip around the sun, the North Pole is tilted toward the sun half the time and away from the sun the other half of the year. This means the shadows cast by the sun change from day to day. In addition, because the Earth's surface is curved, the ground at the base of the shadow stick is not at the same angle to the sun's rays at the equator.

Therefore, the shadow does not move at a uniform rate during the day. Sundials only measure local solar time. If a friend had a sundial 5 degrees longitude to the west of your sundial then his/her sundial would read differently than yours. The Earth turns 360 degrees in about 24 hours, therefore the sun's apparent position moves $360/24=15$ degrees each hour. Your friend's sundial would read 20 minutes different (earlier) than yours. This difference is only affected by longitude, not latitude.

To get an accurate reading, a sundial must be positioned towards **true north**. A compass needle that is attracted to the magnetic field of the Earth points in a direction called **magnetic north**. That is not exactly the same as true north, which is the direction of the Earth's North Pole. The difference between magnetic north and true north is called **magnetic declination**, and it is different in different locations. One way to find true north is to go out at night and look for the North Star, and mark an arrow on the ground that points toward that star. That's true north. Another way is to place a stick in the ground around midday and mark the end of its shadow every 15 minutes. The direction of the shortest shadow is true north.

The Inner Planets or "Terrestrial" Planets

Mercury

Mercury is the planet closest to the sun. It orbits within 46 million km to the sun at its closest point. Its surface temperature reaches 427 degrees Celsius (800 degrees F) on the dayside and -183 degrees Celsius (-297 degrees F) on the night side. Mercury rotates on its axis every 58.9 days and revolves around the sun once every 87.9 days. Its thin atmosphere is composed of sodium and potassium. It is the smallest of all the known planets except for Pluto. Mercury is one-third the size of Earth, but its density is about the same as Earth's. By looking at a picture of Mercury, one can see the impact craters caused by huge meteorites and asteroids crashing into the planet billions of years ago. Mercury's surface is covered by porous, fine-grained soil. The only spacecraft to explore Mercury was Mariner 10 in 1974-75. It took pictures of about half of Mercury, so half of the planet has yet to be explored.

Venus

When comparing Venus to Earth, the two planets are similar in size, mass, composition, and distance from the sun. However, Venus has no oceans and the temperature on the surface can reach 484 degrees Celsius (900 degrees F). Sulfuric acid clouds cover the surface of the planet, and its atmosphere is composed of carbon dioxide. The atmosphere is so dense that it presses down on the planet with the same pressure found at 3,000-foot depths of the ocean. Venus rotates in a clockwise direction, opposite that of Earth. Due to this rotational direction, the sunrise on this planet occurs in the west rather than the east. Venus's day is equal to 243 Earth days. Venus has been visited by more spacecraft than any other planet. Flyby missions, orbiters, surface landers, and atmosphere-floating balloons all have gathered information about this planet. Mariner 2's flyby confirmed Venus's high temperatures. The Pioneer Venus and Venera spacecraft were able to image the surface with radar. The spacecraft, Magellan, in 1990 used synthetic aperture radar to penetrate Venus's thick atmosphere and returned images of 98% of the planet's surface. 900 impact craters are randomly scattered on the surface. Little erosion occurs on the planet because of the lack of rainfall, oceans, or strong winds.

Earth

Our planet is the only planet in the solar system known to accommodate life. All of the things

we need to survive are provided for us on the planet. Air, water, land, and humans combine to create a constantly changing world. Earth is the third planet from the sun and the fifth largest in the solar system. Earth's diameter is a few hundred kilometers larger than Venus is. Our planet rotates on its axis at approximately .5 km/sec at mid-latitudes. Earth orbits the sun at a speed of about 30 km/sec. The four seasons are caused by the Earth's axis of rotation being tilted 23.5 degrees. Oceans cover 70% of the Earth's surface. Water exists in the liquid phase between 0 degrees and 100 degrees Celsius. This temperature span is narrow compared to the temperature spans found in the solar system. On the surface, the air consists of 78% nitrogen, 21% oxygen and 1% other constituents. Our thin layer of atmosphere separates us from the void of space. The water vapor in the atmosphere is responsible for much of the Earth's weather. The Earth's atmosphere shields us from harmful radiation that comes from the sun and protects us from meteors. Most meteors burn up in the Earth's atmosphere before they strike the surface. Earth's rapid rotation and nickel-iron core cause a magnetic field, which is distorted by the solar wind. The solar wind is a stream of charged particles continuously expelled from the sun.

Moon

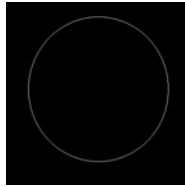
The moon is Earth's one natural satellite and is the second brightest object in the sky. It is the only thing in the sky, other than the sun, that does not look like just a pinpoint of light or fuzzy patch. It is approximately one-fourth the size of the Earth (3456 km in diameter), which is unusually large for a moon. The Earth and moon are sometimes referred to as a double planet system. Its shape is also unusual. It is slightly "egg shaped" with the small end of the "egg" pointing toward the Earth. The gravity on the moon is one-sixth to the gravity on Earth. The moon has an **elliptical** orbit, and it is tilted about 5 degrees to the plane of the Earth's orbit. Its average distance away from the Earth is 384,400 km. Over time, the moon has become "locked" into a motion around the Earth. It rotates on its axis at the same pace as it revolves around the Earth. Therefore, we only get to see one side of the moon throughout its orbit. The moon makes one revolution around the Earth every 29 ½ days, so it takes approximately a month to orbit all the way around our planet. Looking down on the Earth and moon from above the Earth's Northern Hemisphere, the revolution of the moon around the Earth is in the same direction as the Earth's rotation and the Earth's revolution around the sun. Our moon also stays fairly close to the Earth's **equatorial plane**, an imaginary extension of the Earth's equator out in space.

The moon does not have an atmosphere and does not have water. Therefore, it is susceptible to impact craters from meteorites, which are visible on the lunar surface. When a meteor strikes Earth, it makes a crater, like it does on the moon, but the wind and rain and motions of the Earth's crust fill in the craters. Since the moon has no atmosphere, there is no rain or wind to erode the craters. By looking at the moon, one can see dark regions and light regions. The darkened plains on the surface of the moon are known as the **marias**, which is Latin for "seas". These marias are lakes of dried lava from volcanoes on the moon that died a long time ago. Apollo astronauts discovered that the maria regions are smooth, low-lying plains with few craters. The lighter patches are heavily cratered mountains or highlands. Due to the lack of atmosphere, the intense radiation from the sun cannot be blocked out. If one would stand on the surface of the moon, the sky would be black. The lack of atmosphere causes the sky to be black, even during the day, because there is no atmosphere to break the sunlight into colors as there is on Earth.

Phases of the Moon

The moon reflects sunlight. It itself does not glow. Sunlight strikes the moon's surface at different angles throughout its journey around the Earth. The way the moon looks to us depends on how much the illuminated side is visible to us at that time.

**New
Moon**



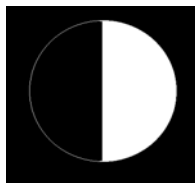
At **new moon**, the sun and moon are close to each other in the sky. The sun's light falls on the part of the moon we cannot see on Earth, or the "farside" of the moon. The side toward us is dark. Since the moon and sun are so near each other in the sky, they are above the horizon at the same time. Thus, the moon is only in the sky during the day, when the sky is bright, so the new moon cannot be seen from Earth. The moon in its new phase will sometimes block all or part of our view of the sun. This event is called a **solar eclipse**.

**Waxing
Crescent**

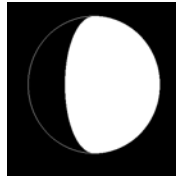


As time passes after the new moon, the moon – orbiting counterclockwise around the Earth – moves away from the sun toward the east from our vantage point. It travels about 12 degrees (or 24 times the moon's width in the sky) per day toward the left, as seen from the Earth's northern hemisphere. Two or three days after the new moon, a **waxing crescent** can be seen to the east of the sun. **Waxing** means it is increasing or growing larger. It is most easily seen just after sunset, following the sun closely down toward the western horizon.

First Quarter

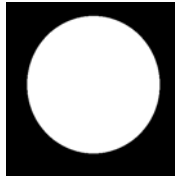


About a week after the new moon, the moon has moved about 90 degrees away from the sun, a quarter of the way around the sky toward the east. Its right-hand half is illuminated by sunlight. The phase is called **first quarter** because it occurs when the moon has completed the first quarter of its orbit from the previous new moon phase. Since it is 90 degrees (1/4 of a circle) away from the sun on the sky toward the East, the moon will lag behind the sun by about 6 hours (1/4 of 24 hours). It will rise at about noon and be at its highest point in the sky at about sunset. During the first quarter and waxing gibbous phases, the moon is easily seen in the eastern sky on a clear afternoon.



**Waxing
Gibbous**

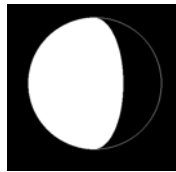
During the following week, the moon continues to further distance itself from the sun toward the east by about 12 degrees per day. As it does, more of the moon visible to us is illuminated by sunshine. This phase is called **waxing gibbous**.



Full Moon

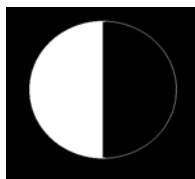
When the moon has completed exactly half of its trip around the Earth from the previous new moon, it is on the opposite side of the Earth from the sun. The side of the moon that faces Earth is fully illuminated – **full moon**. The moon's orbit around the Earth is tilted by about 5 degrees relative to our planet's orbit around the sun. This means that full moon doesn't always bring the sun, Earth, and moon into perfect alignment. If it did, the moon would move directly in to the Earth's shadow, which extends straight back and away from the Earth's shadow. This does happen occasionally through, and it is called a **lunar eclipse**. Near the time of full moon phase, the moon is opposite the sun, therefore it rises around sunset, is high in the sky around midnight and sets around sunrise.

**Waning
Gibbous**



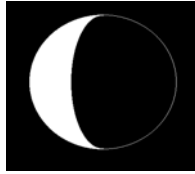
During the week after full moon, as the moon continues to move eastward in its orbit about 12 degrees per day, the moon rises later and later and the side we see is illuminated by less and less sunlight. **Waning** means decreasing or growing smaller. In the **waning gibbous** phase, the moon's left side remains fully lit by the sun, while it gets darker on the right side. It is during this time that the delay of moonrise from one night to the next is easily noticed.

**Last
Quarter**



At **last quarter** phase, the moon enters the last quarter of its orbit back to new moon. The left half of its disk is illuminated. The moon has moved to 90 degrees west of us. The last quarter moon is easy to see in the western sky on clear mornings.

Waning Crescent



Finally, during the last week of its monthly orbit the moon draws closer and closer to the sun in the sky, approaching it from the west (right). The **waning crescent's** points extend toward the west, away from the sun. A day or two after this phase, the moon will be new again, and the cycle begins anew.

Because the cycle of the moon phases is shorter than most calendar months, the phase of the moon at the very beginning of the month usually repeats at the very end of the month. When there are two Full moons in a month (which occurs, on average, every 2.7 years), the second one is known as a "Blue Moon"

Tidal Forces

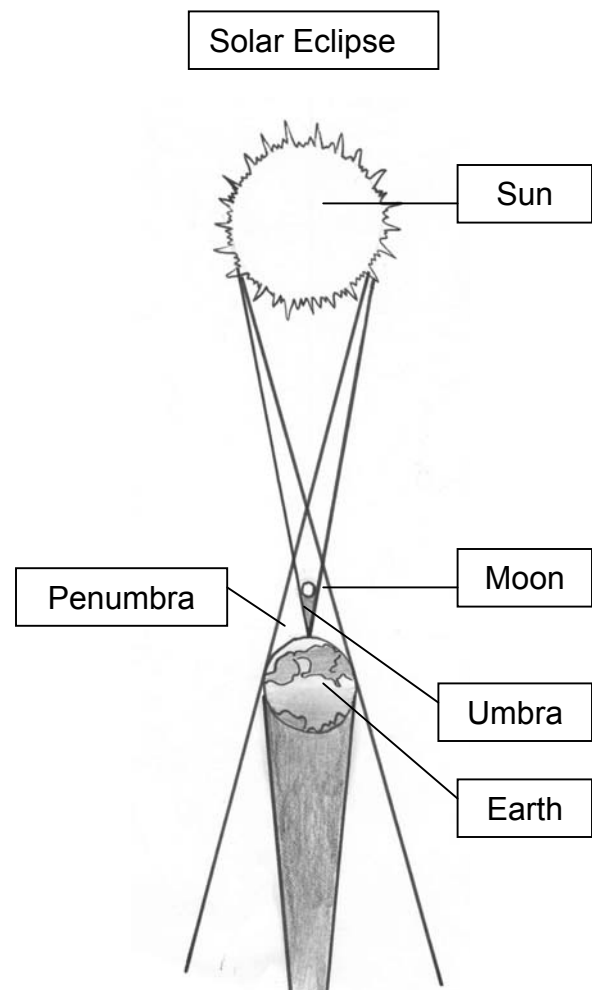
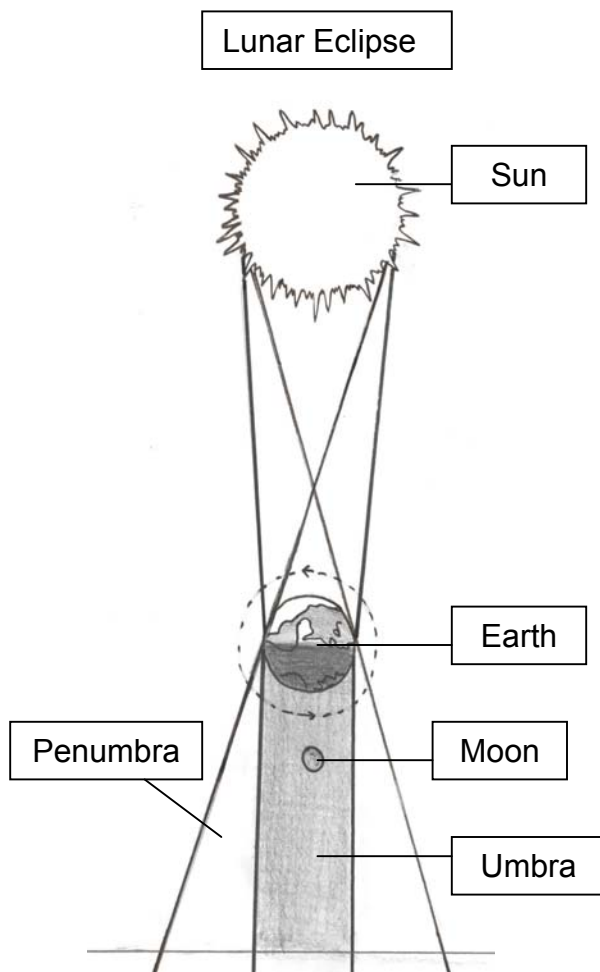
Since ancient times, man has watched the rising and falling of the water level along the seashore. Just as the Earth's gravity pulls on the moon, the moon's gravity pulls on the Earth and its large bodies of water. Bulges form on either side of the planet, and these bulges are called **tides**. The moon's gravity pulls up the water directly below the moon. On the other side of the Earth, the moon pulls the solid body of the Earth away from the water. As a result, two bulges called high tides are formed on the oceans and seas. As the Earth turns, these tidal bulges travel from east to west. Every place along the seashore has two high tides and two low tides daily.

The tidal forces exerted by the Moon on the Earth cause the oceans to bulge



Lunar Eclipses

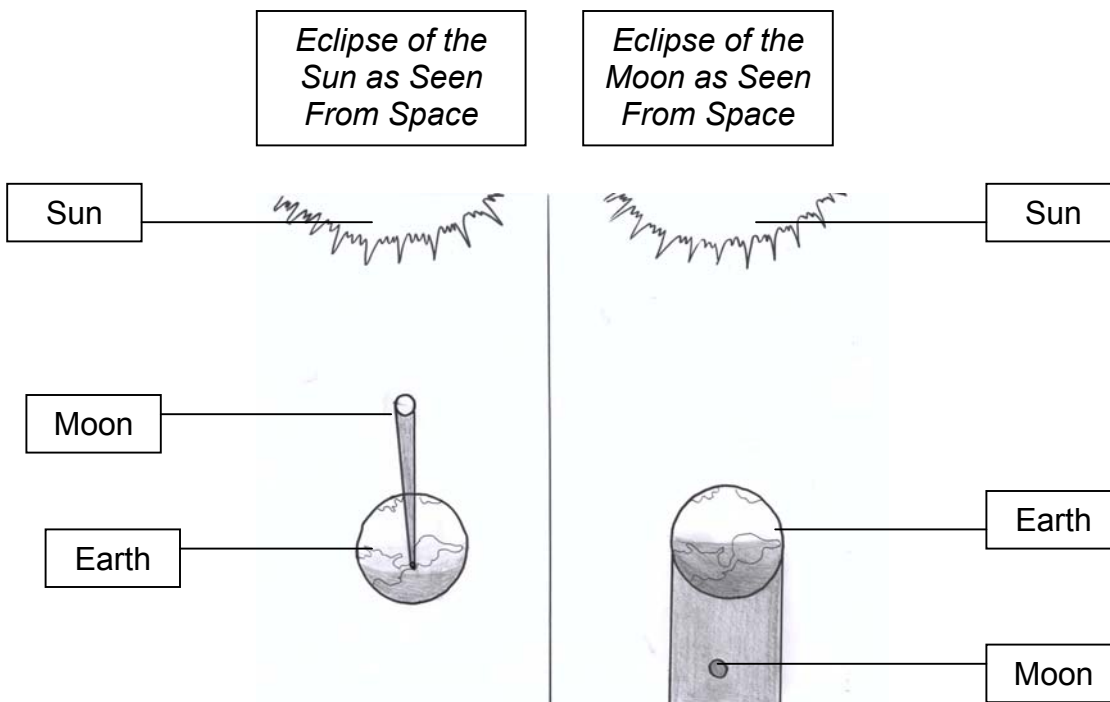
Lunar eclipses take place when certain conditions are met in relation to the sun, Earth, and moon. First, the moon must be in its full phase. Secondly, the sun, Earth, and moon must be in a perfect alignment. If both conditions are met, then the Earth's shadow can block the sun's light from hitting the moon. There are three types of lunar eclipses. Each type depends on the alignment of the sun, Earth, and moon. The Earth's shadow is broken up into two parts. The **umbra** is the darker part of the shadow, where no part of the sun can be seen. The **penumbra** is lighter than the umbra, because part of the sun can be seen. When part of the moon passes through the umbra, it is called a **partial eclipse**. When the entire moon passes through the umbra, this is a **total eclipse**. When the moon only passes through the penumbra, this is called a **penumbral eclipse**. When a lunar eclipse occurs, everyone that is on the night side of the Earth can see the eclipse.



Solar Eclipse

The total eclipse of the sun takes place when the Earth passes through the moon's shadow. An eclipse of the sun takes place only during a new moon when the moon is directly between the sun and the Earth and is positioned just right to cast a shadow on the Earth. The combination of the moon's size and its distance from the Earth causes the moon to appear the same size in the sky as the sun, which is one reason why total solar eclipses are possible. When a total eclipse occurs, the moon's shadow covers only a small portion of the Earth, where the eclipse is visible. Where the darkest part of the moon's shadow reaches the Earth, a total eclipse occurs. In the places on Earth where the lighter part of the moon's

shadow reaches, only a partial eclipse is seen.



Mars

Mars is nicknamed "The Red Planet". It is the inner planet farthest from the sun. Its rotational period is 24.6 hours, which is very similar to that of Earth's. Also, similar to Earth, its north and south poles have ice caps. It is a small rocky planet that has experienced some of the planetary processes as the other "terrestrial" planets that include volcanism, impact events, and atmospheric effects. Layered terrains near the poles suggest that the planet's climate changes have been periodic. Tectonics on Mars result in plates that seem to move vertically with hot lava pushing upwards through the crust. Great dust storms periodically occur on the entire planet. The effects of these storms include dunes and wind-carved features. The largest volcanic mountain in the solar system is found on Mars, Olympus Mons (27 km high, 600 km across). The main component of the atmosphere on Mars is carbon dioxide, and the temperature range on this planet is -143 degrees Celsius (-225 degrees F) to 17 degrees Celsius (-62 degrees F).

The Outer Planets- The "Gas Giants"

Jupiter

Jupiter contains two-thirds of the planetary mass of the solar system, and it is the largest of all the planets. Its interior pressure may reach 100 million times that of Earth's, and it has an immense magnetic field. This magnetic field stretches millions of miles into the solar system and billions of watts are provided to the Earth's magnetic field daily. Jupiter has 16 moons. Some of the moons are icy, while some are rocky, some are cratered, and some are smooth. The fifth moon from Jupiter, is actively volcanic. There is also a thin ring system around Jupiter that is composed of three bands that are optically dark. Jupiter has a large, complex atmosphere. Its atmosphere's main components are hydrogen and helium. The atmosphere contains huge storm systems, including the Great Red Spot, which is a storm that has gone on between 100-300 years. The Great Red Spot is about three times the size of Earth. Its

rotational period is 9 hours and 55 minutes, but its revolution around the sun takes as long as 11.86 Earth years.

Saturn

Saturn is the sixth planet from the sun, and it is one of the planets that we can see from Earth without a telescope. It is known for its complex ring system, although the origin of the rings is unknown at this time. We know today that Saturn has 7 major ring divisions. Galileo was the first to see Saturn's rings, and the Dutch astronomer, Christiaan Huygens, with his improved telescope observed that they are actually separate from the planet. Telescopes have also helped us see the "flattening" at its poles. Ring particles have been found to be composed mostly of ice crystals that range in size from a few centimeters to a few meters long. It is a planet with 8 moons. Saturn's atmosphere is very unique. The atmosphere consists mostly of hydrogen and helium and trace amounts of other elements. There are alternate jet streams that can be traced in the motions of the cloud tops on the planet. The planet's atmosphere also features storm structures similar to Jupiter's Great Red Spot. Saturn's rotation takes 10 hours and 40 minutes, and its revolution around the sun is equal to 29.46 Earth years.

Uranus

Uranus's orbit extends 19 times farther from the sun than the Earth's orbit. It spins like a top, almost on its side, with its rotation period being equal to 17 hours and 14 minutes. The motion of the planet leads to extreme seasonal changes. Over the period of one Uranian year, equal to 84 Earth years, the polar regions of the planet go through four seasons, with constant sunlight in the summer and total darkness in the winter. Winters and summers extend for 21 Earth years, yet the temperature of the clouds around the planet remain constant at -220 degrees Celsius (-361 degrees F). It is so far from the sun that it receives 360 times less energy than Earth. Uranus has a system of 11 thin, separated rings. It also has 15 moons that revolve around the planet.

Neptune

Scientists discovered Neptune while trying to understand the orbit of Uranus. When scientists studied Uranus, they found that its orbit was slightly different from a previous theory. They hypothesized that Uranus's orbit was due to the gravitational pull of another planet. It was after that hypothesis was made and research was done that Neptune was discovered. Neptune orbits the sun every 165 years. Neptune has four thin rings of varying thickness so they cannot be fully viewed from Earth. Neptune shows several large, dark spots. The largest spot, called the Great Dark Spot, is about the size of Earth and is similar to the Great Red Spot on Jupiter. Neptune's day is approximately 16.11 hours and it takes it 164.79 years to revolve around the sun. It has eight moons, and one of the moons, Triton, was found to have geyser-like eruptions on it.

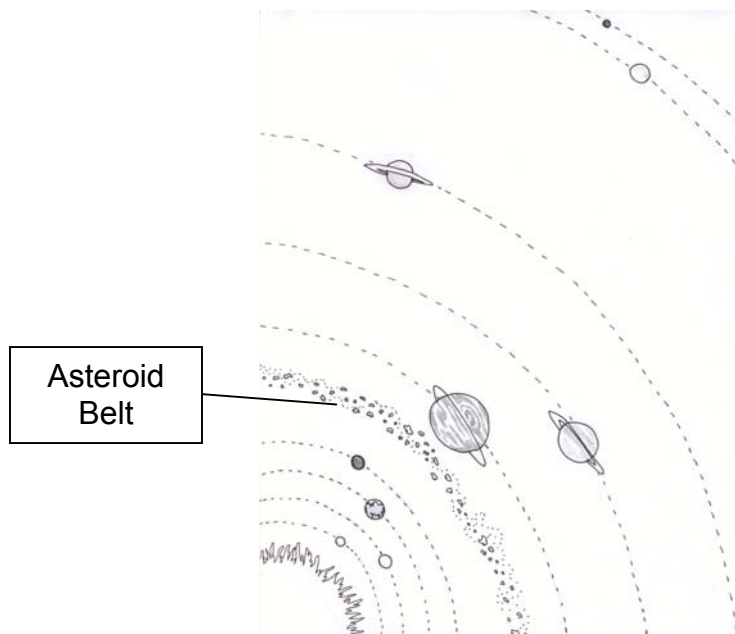
Pluto

Pluto is the smallest planet, coldest planet, and is usually the planet farthest away from the sun. Its orbit is the most elliptical and tilted. Because its orbit is so elliptical, Pluto grows much colder during the part of each orbit when it is traveling away from the sun. In fact, Pluto's orbit is so highly eccentric compared to the orbits of the other planets that every 248 years Pluto is closer to the sun than Neptune, as was the case from 1979-1999. It remains the only planet that has never been visited by spacecraft. It is only 2,400 km across, so it is smaller than the Earth's moon. Pluto's surface is made up of methane, nitrogen, and carbon monoxide. This planet's atmosphere is not very dense, and the atmospheric pressure is one-millionth to that of

Earth's. It has polar caps and large, dark spots near its equator. Pluto's moon, Charon, is almost half the size of Pluto. Most scientists refer to Pluto-Charon as a double planet.

Asteroids

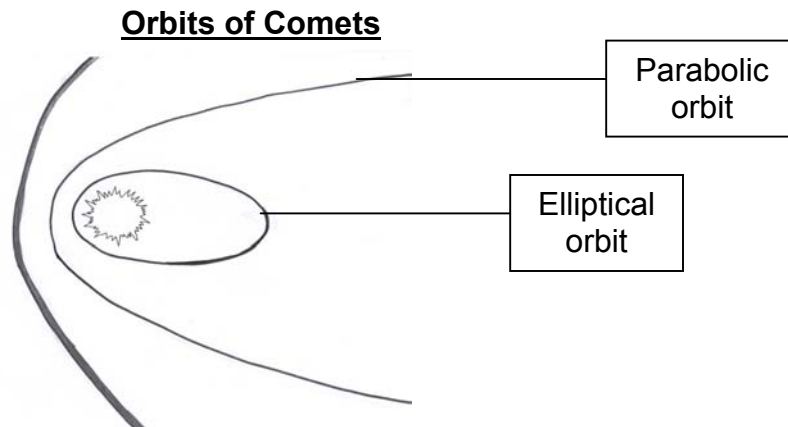
Asteroids are rocky fragments left over from the formation of the solar system. Scientists sometimes refer to asteroids as minor planets. They are found orbiting the sun in a belt between Mars and Jupiter called the **Asteroid Belt**. The largest of these asteroids is called Ceres, which measures 940 km (580 miles) in diameter. It is one-fourth the size of our moon. There are some asteroids that are only 1 km across. Asteroids orbit the sun in an elliptical orbit. Sometimes in this elliptical orbit, asteroids knock into one another and knock each other out of the Asteroid Belt. Stray asteroids or fragments of them may have hit Earth in the past. Pictures taken of asteroids show them to be irregular in shape with craters and fractures.



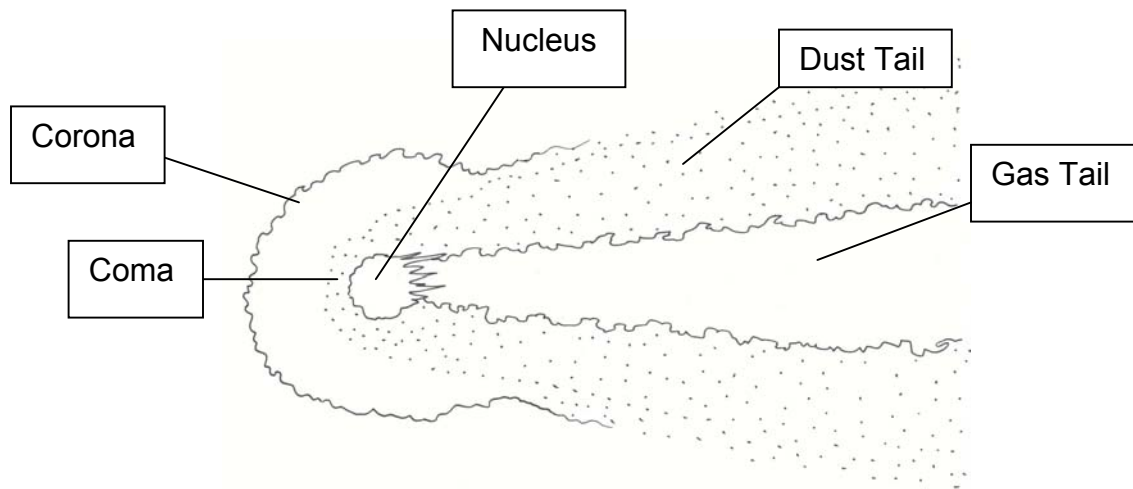
Comets

Comets are balls of ice mixed with pebbles and rocky material. It is often described as a “dirty snowball” leftover from the formation of our solar system. It was first theorized by Dutch astronomer Jan Oort that comets with a long orbital period come from a large “cloud” from a distant region of the solar system within the range of 5-8 trillion kilometers or more from the sun. This cloud is known as the **Oort Cloud**. The total number of comets in this belt was estimated as a trillion. A few of these trillion comets manage to travel into the inner solar system and are seen from Earth. This cloud remains only a theory, as it has never directly been detected. The **Kuiper Belt** is a region theorized by Dutch-American astronomer Gerard Kuiper. Kuiper believed that a belt of comets probably existed outside the orbit of Neptune within the range of 2.8 to 4.6 billion miles from the sun. He felt the Oort's cloud of comets did not account for the population of comets with short orbital periods (making complete orbits around the sun in less than 200 years).

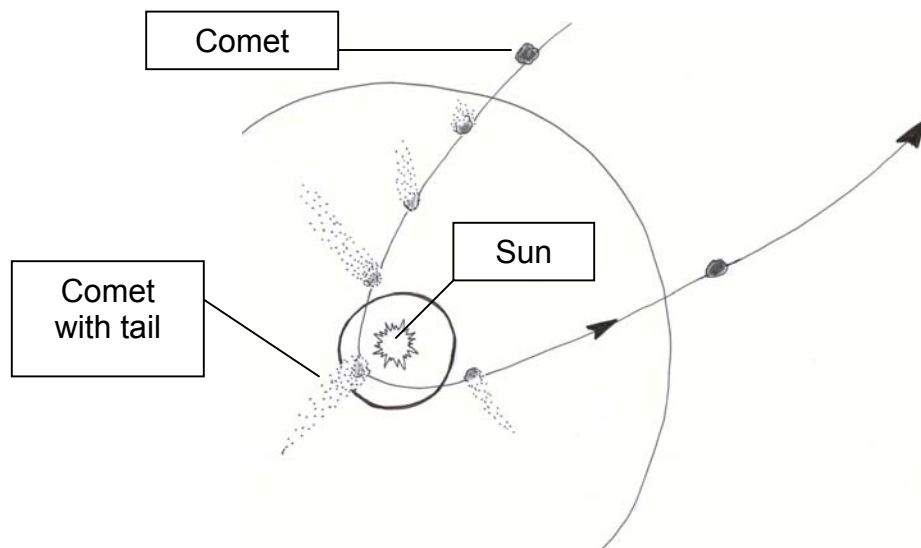
Comets can have an elliptical orbit and a parabolic orbit. If a comet has been “captured” by the sun's gravity, its orbit forms in the shape of an ellipse. All **periodic comets**, or comets that return after a certain number of years, like Halley's Comet, have orbits with this shape. If a comet is just barely captured by the sun, it is susceptible to capture by Jupiter or Saturn. If this occurs, it will orbit in a parabolic orbit. Comets with this type of orbit do not return unless their orbit is changed.



Each comet has a tiny solid part, called a **nucleus**. The nucleus is no bigger than a few kilometers across. The nucleus contains icy chunks and frozen gases with bits of embedded rock and dust. Because its crust is black, it absorbs the heat which causes some of the ice to turn to a gas. The crust then cracks from the pressure and the gas shoots outward. As these jets of gas appear, a dust shell forms around the nucleus forming a **coma**. The coma is typically several thousand kilometers in diameter. The jets appear on the side that is facing the sun (the warmest side). As a comet begins its pass toward the sun, it warms up and turns from a dark, cold object into a bright one. It is so bright that we can see it from Earth. When comets get close to the sun, its heat causes the solid material to turn directly to a gas. This is called **sublimation**. This is the same process when dry ice produces a cloud of gas. The charged particles blown off the sun is called the **solar wind**. The solar wind particles push back charged particles from the comet forming its **ion tail or gas tail**. It always points away from the sun, whether the comet is moving toward or away from the sun. The **dust tail** on a comet is caused by solar wind pushing on microscopic dust particles released from the sublimating gas and pressure from the light from the sun.



Solar energy and the solar wind blows the coma materials away from the sun. This forms the comet's "tail". The tails of comets always point away from the sun. There are some comets, called **sungrazers**, which crash straight into the sun or get so close to the sun that they burn up. Comets can remain visible for several weeks then slowly fade from view.



Meteoroid, Meteor, Meteorite

Meteoroids are formed from rocks and metal, and they contain information about events that took place in our solar system more than 4.5 billion years ago. Most meteoroids come from the break-up of small asteroids that never formed a planet or a piece of ice from a comet.

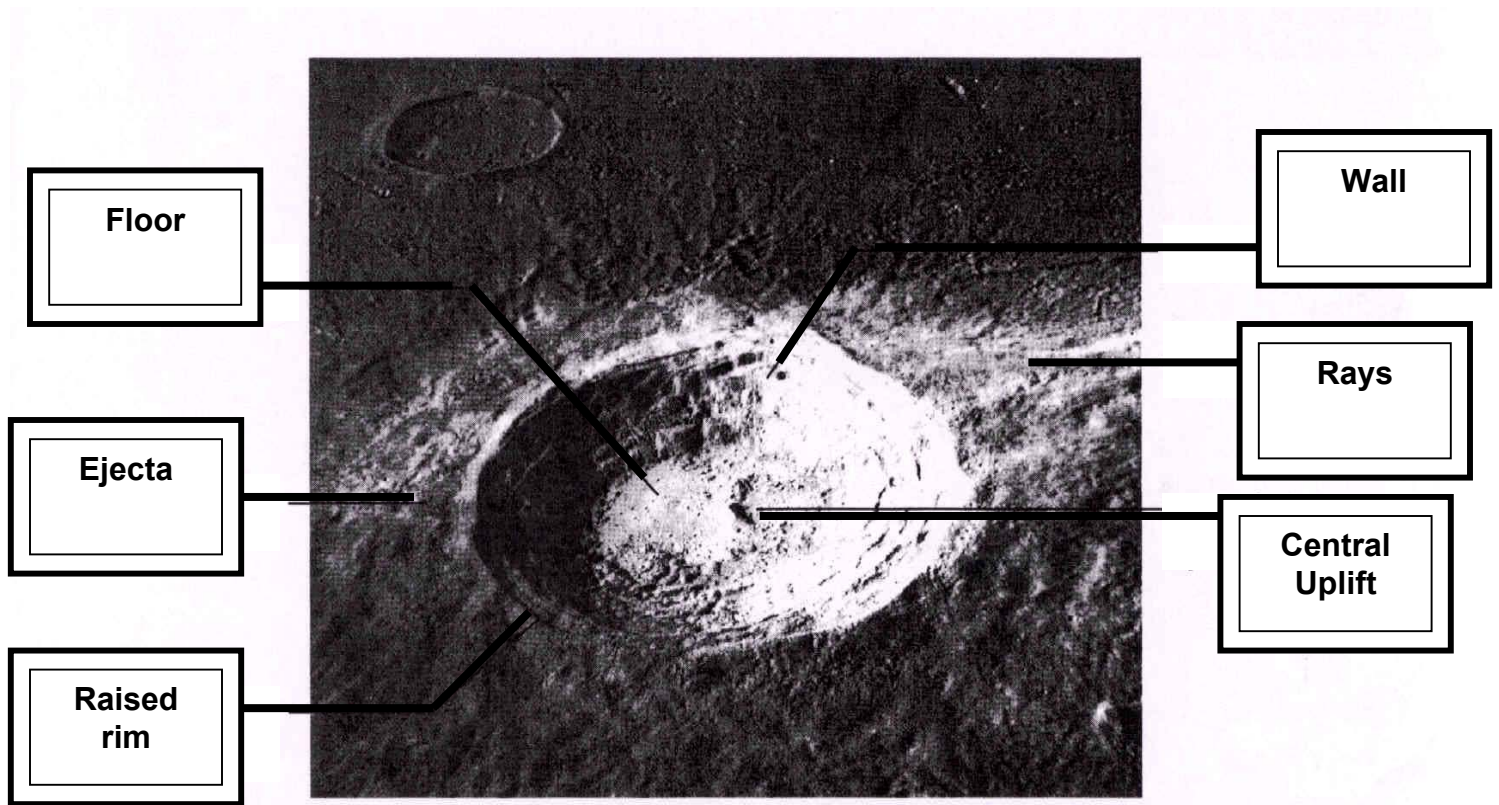
Meteoroids are those objects in space that may enter our atmosphere. **Meteors** are those meteoroids that do come in contact with the Earth's atmosphere, and **meteorites** are the meteors that fall to the surface of the Earth. When meteors hit the atmosphere, meteors rub against air particles and create friction, heating the meteors to more than 1648.9 degrees Celsius (3000 degrees F). The heat vaporizes most meteors, creating shooting stars.

Shooting stars are meteors that you see streaking through the night sky, but their streaks of light vanish after just a flash. Whether an object breaks apart when it enters the Earth's atmosphere depends on its composition, speed, and angle of entry.

Meteor showers occur when a comet is near the sun and dust and other debris burns off of it and leaves a trail. This trail continues to circle the sun, and when Earth passes through this debris, we experience a meteor shower. Meteor showers are composed of large numbers of meteors burning through the atmosphere. Every year the Earth passes through meteoroid material causing annual showers. Since the intersection of the Earth with this comet debris occurs at the same times each year, it is a regular and predictable event.

Large meteorites can make craters on Earth and other planetary bodies. The most famous meteorite crater in the United States is misnamed a meteor crater. It is in Arizona, and the rim rises 150 feet from the surrounding plain. The hole is nearly a mile wide. It was the first crater proved to be caused by a meteorite impact 20,000-50,000 years ago.

Meteor Crater



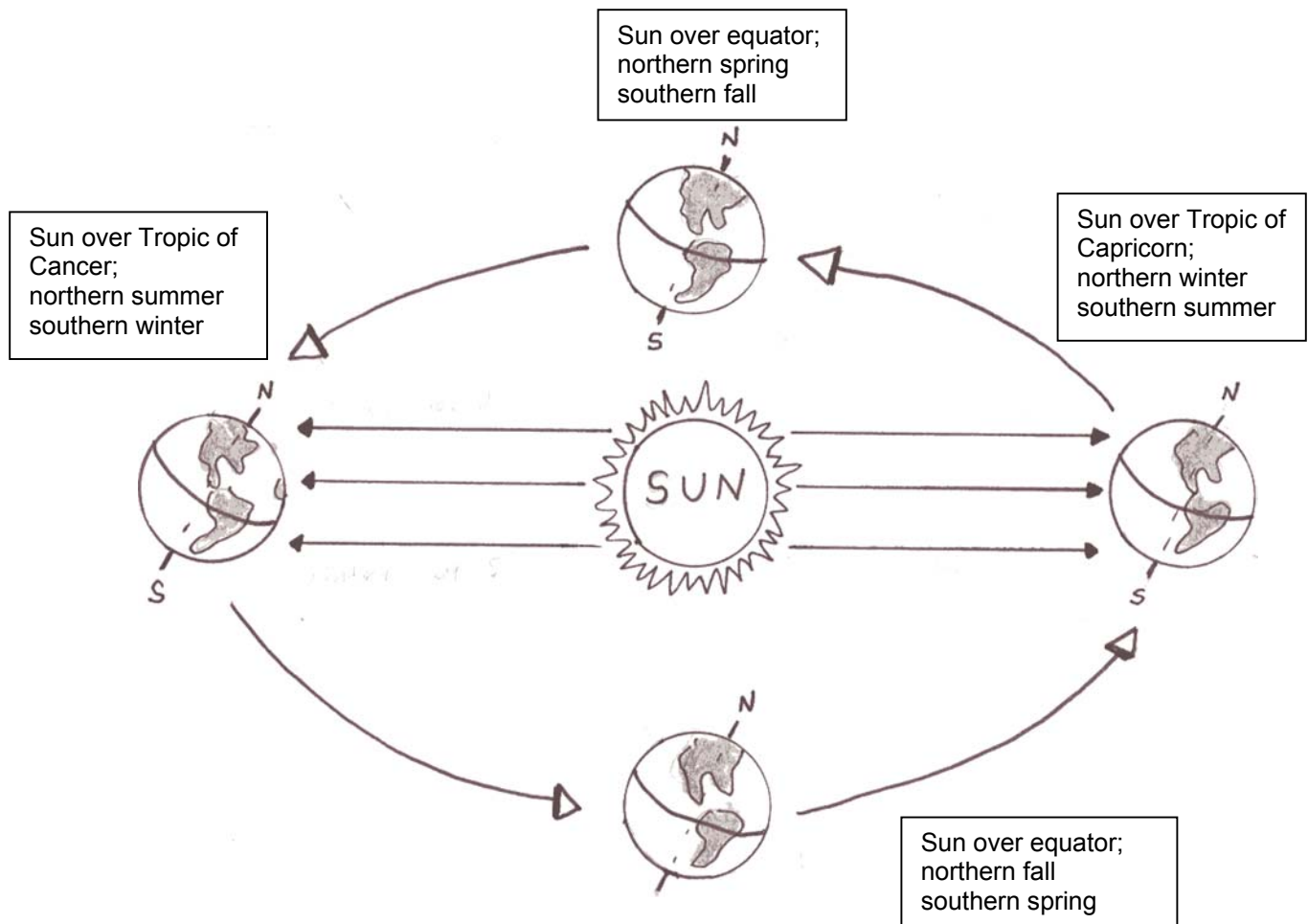
Time & Seasons

An imaginary line or **axis** runs through the Earth from the North Pole to the South Pole. The Earth rotates on this axis. It takes about 24 hours for the Earth to make one complete rotation. This rotation causes day and night. When the Earth is rotating, the part of the Earth that receives light from the sun is experiencing daytime. However, as that same part of the Earth rotates away from the sun it experiences nighttime.

The Earth is located 93 million miles away from the sun. Earth years are determined by the time it takes the Earth to orbit the sun (just over 365 days). The Earth follows a path around the sun. This path is called an **ellipse**. Because of this oval-shaped path, the Earth comes closer to the sun during our winter. This increases the amount of solar heat the Earth receives. However, this path does not cause the seasons.

Seasons

The Earth is tilted about 23.5 degrees on its axis. This axis always points in the same direction, so the North Pole always points towards the Star, Polaris. It remains tilted in this same direction as it travels around the sun. Sometimes the Northern Hemisphere is pointed toward the sun and sometimes it is pointing away from the sun. The same is true for the Southern Hemisphere. This tilt of the Earth is what causes our seasons. As the Earth orbits the sun, different parts of the planet are tilted toward the sun. Therefore, different parts of the world experience different amounts of heat throughout the year.



The Northern Hemisphere is tilted away from the sun during the winter months. Less light reaches this hemisphere causing lower temperatures and shorter days. As the Earth moves in its orbit, the North Pole gradually begins to tilt toward the sun. In the spring (Vernal Equinox - March 21), the sun is higher in the sky and days are longer. When the Earth orbits around the sun, the North Pole is tilted toward the sun, daylight increases causing the longest day of the year, the Summer Solstice, June 21. The sun is at its highest height in the sky, and the sun is directly overhead at the Tropic of Cancer. The Earth continues its orbit around the sun, and the North Pole begins to tilt away from the sun again (Autumnal Equinox - September 21). Daylight begins to decrease again and continues to decrease until the Winter Solstice, December 21, the shortest day of the year. In the Southern Hemisphere, the seasons are opposite of those in the Northern Hemisphere. When it is summer in the Northern Hemisphere, it is winter in the Southern Hemisphere.

	Northern Hemisphere	Southern Hemisphere
December 21	Winter Solstice	Summer Solstice
March 21	Vernal (Spring) Equinox	Autumnal Equinox
June 21	Summer Solstice	Winter Solstice
September 21	Autumnal Equinox	Vernal (Spring) Equinox

The four seasons occur in the middle and high latitudes, however, in the tropics between Tropic of Cancer and Capricorn the amount of sunlight varies much less. In the tropics, the two seasons are wet and dry. When the sun is directly overhead in the tropics, precipitation is at its maximum (Tropical of Cancer = June, Tropic of Capricorn = December)

Learning Experience 1: Getting Started

Objective: Students will use their background knowledge to contribute ideas to a KWLH chart on the solar system.

Materials:

For the class:

Chart paper*
Felt tip markers*
Notebooks*
Folders*

*provided by teacher/student

Preparation:

Read background information on pages 3-20. Each student should obtain a notebook and folder with pockets to hold the activity sheets for this unit. Create a KWLH chart to post in the classroom.

Basic Skills Development:

Discussing
Brainstorming

Evaluation Strategy:

Students will use their background knowledge to contribute ideas to a KWLH chart.

Vocabulary:

solar system
strategy

What do we know about the solar system?

Using the KWLH Strategy, students will explore their knowledge about the solar system and then expand on it throughout the unit.

Brainstorm all that the students already **know** about the solar system. Record their ideas on a class-size KWLH chart. Ask students what they would like to know more about concerning the solar system and record their ideas under the "**want to know**" column. Now that the students have decided what they want to know, they need to think about "**how they are going to find out**" the answers to the questions they have. After the hands-on activities, maintaining journals, and discussions, students can then record information into the "**what we learned and still want to learn**" column. This process can also be done in cooperative groups where students gather information in small groups then share with the class.

KWLH Strategy			
What we know	What we want to know	How are we going to find out	What we learned and still want to learn

Learning Experience 2: Our Star: The Sun

Objective: Students will model the movement of the Earth in relation to the sun, model the size of the sun in relation to other stars and research the structure of the sun.

Materials:

For each student:

Solar System Student Activity Book

Construction paper (white, orange, red, yellow)*

Scissors*

Glue*

Metric ruler*

For the class:

Balloon

Metal stake

Glass marble

Metric tape measure

Straight pin

Flashlight (or lamp)*

2 "D" batteries

Globe

Compass

Overhead transparency/pen*

Research material (books, video, internet)*

Tape*

Straw (optional)*

Modeling clay (optional)*

Large piece cardboard (optional)*

*provided by teacher

Preparation:

Read the background information on pages 6-8, 19-20. A large model of the sun's structure will help students with the labeling of the parts of the sun. Finding the position of true north will need to be found before students can create their sundial watches. An area of the classroom/hallway will need to be chosen for Session 2 of this learning experience.

Basic Skills Development:

Creating Models

Discussing

Observing

Why is the sun important to our planet?

Session 1:

As a class, begin this learning experience by creating a list of reasons why the sun is important to life on Earth. Take this opportunity to focus on the energy it provides the Earth depending on the time of day, season, and location in the sky. Begin focusing on how the sun and the rotation of the Earth causes day and night.

Gather the class around a flashlight or lamp and explain to the students that their heads represent the Earth, and the light represents the sun. Have students pretend that someone is living on the tip of their nose. Begin a dialogue with students that allows them to role play the rotation of the Earth:

"Your head is the Earth, and you are directly facing the sun. For the person living on your nose, where is sun in the sky?" (high in the sky)

"What time of day is it for that person?" (around noon)

"Turn to your left and stop when your right ear is facing the sun. For the person living on your nose, where would the sun be in the sky?" (low in sky, near horizon)

"What time of day is it for that person?" (sunset)

"Continue to turn to the left, stop when your backs are to the light. What time is it for the person living on your nose?" (midnight)

"On what part of your head is it daytime?" (back of head because it is facing the sun)

"Keep turning to the left until your left ear is facing the sun. Where is the sun in the sky to the person on your nose?" (low in the sky, rising)

"What time of day is it?" (sunrise)

"Hold your hands to the side of your head to form a horizon. The left hand is the eastern horizon and the right hand is the western

Learning Experience 2 continued

Page 2

Evaluation Strategy:

Students will model the movement of the Earth around the Sun and research the parts of the Sun and their importance.

Vocabulary:

core
rotation
revolution
axis
sunspots
radiation zone
solar flares
convection zone
star
sun
solar
photosphere
chromosphere
corona
equinox
solstice
constellation

horizon. Turn slowly and watch where the sun rises and sets.

Discussion Questions:

What causes day and night?

How long does it take the Earth to rotate one time? (approximately 24 hours)

How many rotations does the Earth make in one week? (7x) (one year 365X)

Review with students what causes the seasons. Demonstrate the revolution of the Earth around the sun by using a globe and a flashlight or lamp. The lamp will play the role of the sun. The Earth is tilted on its axis (23.5°). The axis points toward the North Star as it orbits around the sun. Because of the Earth's tilt on its axis, ask students to observe what parts of the Earth are receiving light/heat from the sun with different intensities.

On the summer solstice, due to the Earth's tilt on its axis, the sun is directly over the Tropic of Cancer. The sun is at the highest point in the sky. Therefore, the energy coming from directly overhead is more concentrated, providing more heat. On the winter solstice, the sun is above the Tropic of Capricorn. The sun is at the lowest point in the sky in the Northern Hemisphere. Its light and heat are being spread out over more surface area. In addition, the sun is in the sky for a short time because it is the shortest day of the year. During the spring and fall equinox, day and night are almost equal and the sun is in between the highest points and lowest points in the Northern Hemisphere's sky. Therefore, when the Northern Hemisphere is in the summer and the Southern Hemisphere is in the winter, the Northern Hemisphere is tilted toward the sun. When the Northern Hemisphere is in the winter and the Southern Hemisphere is in the summer, the Northern Hemisphere is tilted away from the sun. Remember the Earth keeps rotating as it is orbiting around the sun. Because the Earth is

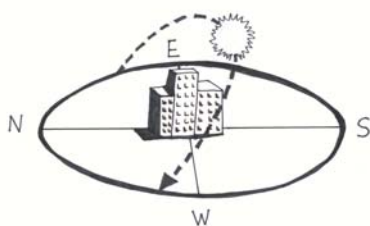
Learning Experience 2 continued

Page 3

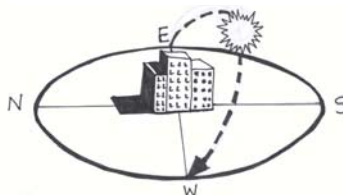
pointed toward the sun during the summer months, it results not only in warmer temperatures but longer days during the summer. The opposite is true in the winter. In the spring and fall, the sun is over the Equator, and it is again the tilt of the Earth that determines if it is spring or fall in the Northern or Southern Hemisphere.

Students can use the globe and flashlight to demonstrate the reason for the seasons for the class, as well.

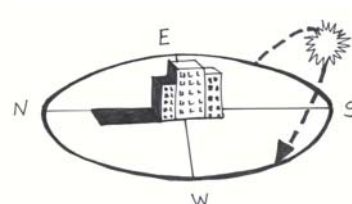
Summer Solstice
June 21
(longest day of the year)



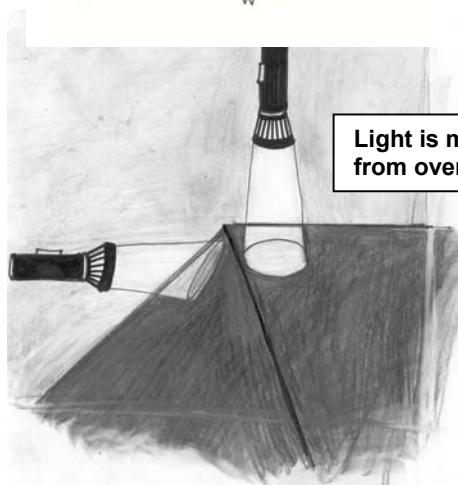
Spring or Fall Equinox
March 21 or September 21
(day and night almost equal)



Winter Solstice
December 21
(shortest day of the year)



Light hitting at an angle is less concentrated.



Light is most concentrated from overhead source.

	Northern Hemisphere	Southern Hemisphere
December 21	Winter Solstice	Summer Solstice
March 21	Vernal (Spring) Equinox	Autumnal Equinox
June 21	Summer Solstice	Winter Solstice
September 21	Autumnal Equinox	Vernal (Spring) Equinox

Discussion Questions:

What does the tilt of the Earth on its axis cause? (the seasons - in winter the Northern Hemisphere is tilted away from the sun and in the summer, it is tilted towards the sun)
In what position is the Northern Hemisphere pointed away from the sun?
What is happening in the Southern Hemisphere?
In what position would the Northern Hemisphere be when it is having its spring? Fall?
What would be happening in the Southern Hemisphere?
In what seasons do we have the longest day? Shortest day?
How long does it take the Earth to revolve around the sun? (365 ¼ days, we add one extending day every four years to make up part of that day – leap year)

Learning Experience 2 continued

Page 4

Discuss with students how the sun and an instrument called a sundial was used in ancient cultures to measure time. The directions for making a sundial are found on the activity sheet for Learning Experience #2 in the Solar System Student Activity Book. Before students go outside to plot their shadows on their sundial watches, the direction of true north must be found. A compass points to magnetic north, which is not the same as true north. Students must face in the direction of true north for best accuracy on their sundials. To find true north, find a level spot of ground and place one of the metal stakes upright in the ground. Mark the end of its shadow every 15 minutes through the middle part of the day. Notice where the shadow is the shortest. That is true north. After the direction of true north has been found and when students have created their sundial, go outside and have them lay them on the ground so the **vertical edge of the triangle points to true north**. They are to use pencils to mark and label the shadow for each hour during the day. A piece of tape can be attached to the end of the construction paper band and wrap around the wrist. During the next few days, students can go outside with their sundial watch to tell time. Remind them they must face true north to do this accurately. If a whole class sundial is preferred, it can be made by using a piece of cardboard, modeling clay, and a straw. Place the modeling clay in the center of the cardboard and stick the straw in the center. Use a ruler to draw the line of the shadow that falls from the straw at different times of the day. Label the time of day for each shadow marking.

Session 2:

Now that we know what the sun does for the Earth and the Earth's movement around the sun, students are to concentrate on its structure and size. The sun is a star, however, its size appears so much larger than the other stars in the sky. The sun is the closest star to the Earth, therefore, its size appears larger than the other stars in our universe. In reality, the sun is an average size star. The next star closest to Earth is Proxima Centura. To get to that star beyond Pluto, it would be like walking to San Francisco, California. Blow up a yellow balloon to 14 cm in diameter and compare this size sun to the 2.5 cm (1 inch) large glass marble. Compared to a sun 14 cm in diameter, Proxima Centura would be the size of the 2.5 cm glass marble.

Now discuss with students the star, Alpha Orionis, also known as Betelgeuse (sounds like beetle juice). It is found in the constellation of Orion, The Hunter. It is the 12th brightest star in the sky. While it is cooler than our sun, it is over 1000 times larger. If it was in the center of our solar system, it would extend past Jupiter. Use the tape measure to measure a length of 2.43 meters (8 feet). Students can visualize this star if they think of a ball at this height. Ask students to predict what size our sun would be compared to Betelgeuse. Our star would be the size of the head of a pin (show example). What size would the Earth be? It would be so small you would not even be able to see it compared to this star. So ask students why is it that our sun is so small compared to Betelgeuse that looks like a point of light in the night sky. The reason for this visual difference is distance. The stars we see in the sky are like our sun but at such a great distance that they look only like points of light. This can be demonstrated in a number of ways. For example, if one walks up to a tree in the schoolyard, one is close up to it so the tree shows its immense size. However, the farther away one gets from the tree, the tree appears to shrink in size. It appears so small in fact, that it seems one can hold it between their fingers. The distance is what causes the small appearance, but the size of the tree did

Learning Experience 2 continued

Page 5

not change. When Buzz Aldrin was on the moon, he held his thumb up and made the Earth “disappear”.

Ask students to look at the size of the globe provided at close range. Then find a location in the room or hallway where the globe seems to disappear when one holds their thumb up in front of it. Students can also see this size change with distance with a circle that is cut out of a piece of construction paper and then traced on an overhead transparency. Tape the same circle on a distant wall and hold up the transparency and trace the circle that is on the wall from a distance. Compare the size of the circles. The circle that they traced close up would have traced larger than the circle they traced at a distance.

Now that we know what the sun does for the Earth, the Earth’s movement around the sun, and its size in comparison to other stars, students are to concentrate on our sun’s structure. Divide students into eight groups. These groups are to use books, the internet, and other resources to research the different parts of the sun (core, radiation zone, convection zone, chromosphere, photosphere, sunspots, solar flares, corona). Once they have their information on each part of the sun, students are to put together their model sun, illustrated on their activity sheet for Learning Experience #2 in the Solar System Student Activity Book. Once models are put together, groups can orally present the information they researched. Groups can instruct students which part of the “sun” to label with the part they researched. The corona, photosphere, chromosphere, and solar flares have already been drawn on the activity sheet for their model. As a class, summarize the oral report into a statement or two that would give specific information about that part of the sun’s structure. Then students can record that information on their activity sheet.

Learning Experience 3: Research the Planets/Moon

Objective: Students will research the planets of the solar system and use the information from their research to create scale models of the solar system.

Materials:

For each pair of students:

2 Solar System Student Activity Books
Research materials (books, videos, internet)*

For the class:

Globe
Flashlight or lamp*
Chart paper*
Felt tip markers*

*provided by teacher

Preparation:

Read background information on pages 8-16. Students will need to be assigned a planet to research. More than one student pair can research the same planet then the information can be compiled or the class can be divided into ten groups. A class chart will need to be drawn before beginning this learning experience.

Basic Skills Development:

Gathering Data
Interpreting Data
Comparing
Discussing
Communicating

Evaluation Strategy:

Students will research various facts on the planets of the solar system and the Earth's moon.

Vocabulary:

planet	compare
diameter	contrast
moon	
rotation	
revolution	
temperature	
axis	

How are the planets alike or different?

Students began this unit by thinking about what they already know about the solar system. In this learning experience, students will expand their knowledge base by conducting research on factual data on a planet or the Earth's moon. The information in their research will be compiled into a class chart on the solar system. The information in this chart will be used in future learning experiences of this unit. Students will record their information on the activity sheet for Learning Experience #3 in the Solar System Student Activity Book.

One piece of research the students will be gathering concerns the rotation and revolution of the planets around the sun, and the moon around the Earth. Before students begin their research, review the differences between rotation and revolution with a flashlight and globe as was modeled in the previous learning experience.

Once students have demonstrated understanding of the differences between rotation and revolution, they can go on and research the information on their planets. Fill in a class chart with the information the students gather. This information will be used in future learning experiences. A sample chart is provided on the page 28.

Learning Experience 3 continued

Page 2

<i>Planets and Earth's Moon</i>	<i>Diameter of Planet (km)</i>	<i>Distance from sun (millions of kilometers)</i>	<i>Length of year (revolution around the sun)</i>	<i>Length of day (rotation)</i>
Mercury	4,900 km	57.9	88 days	59 days
Venus	12,100 km	108.2	225 days	243 days
Earth	12,756 km	149.6	365 days	23 hours 56 minutes
Mars	6,800 km	227.9	687 days	24 hours 37 minutes
Jupiter	143,200 km	778.3	11.9 years	9 hours 55 minutes
Saturn	120,600 km	1,427	29.5 years	10 hours 39 minutes
Uranus	51,800 km	2,870	84 years	17 hours 14 minutes
Neptune	49,500 km	4,497	165 years	16 hours 7 minutes
Pluto	2,300 km	5,913	248 years	6 days 9 hours 18 minutes
Moon	3,476 km	152.8	0	27 days 8 hours

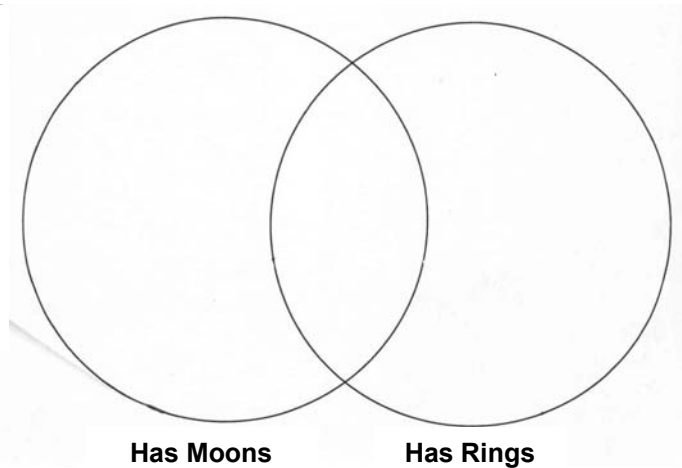
	<i>Rings</i>	<i># of moons</i>
Mercury	No	0
Venus	No	0
Earth	No	1
Mars	No	2
Jupiter	Yes	16
Saturn	Yes	18
Uranus	Yes	15
Neptune	Yes	8
Pluto	No	1
Moon	No	0

Learning Experience 3 continued

Page 3

Session 2:

Now that the data on the planets have been gathered, use various venn diagrams to compare/contrast the planets. See sample venn diagram below:



In a later learning experience (Learning Experience #11), students complete a more in-depth research project on one of the planets that will extend beyond the data type information.

Learning Experience 4: Size of the Planets

Objective: Students will compare the size of the sun and planets and place the planets in the correct order, from the sun outward, in a walking model of the solar system.

Materials:

For each pair of students:

2 Solar Systems Student Activity Books

2 poppy seeds

2 mustard seeds

Popcorn kernel

Pea seed

Gum ball

Piece of black pepper

Mini-marshmallow or Kix cereal*

Research materials (books, videos, internet)*

For the class:

Yellow balloon (blown up to 14 cm in diameter)

Metric ruler*

Chart paper*

9 index cards*

Tape*

*provided by teacher

Preparation:

Read background information on pages 8-9, 14-16. If index cards with the names of the planets are taped to the chalkboard, designate an area of the chalkboard where the cards can remain throughout the rest of the unit.

Basic Skills Development:

Predicting

Creating Models

Discussing

Comparing

Evaluation Strategy:

Students will create a model that compares the size of the Sun and the planets and order the planets in the solar system from the Sun outward.

Vocabulary:

solar system

sun

model

compare

star

diameter

planet

How large is Earth compared to the sun and the other planets?

Ask students to think about the largest thing they have ever touched. They may list a variety of items and the Earth may/may not be one of them. The Earth is the biggest thing we have ever touched, however, it is not the largest planet in the solar system.

Explain to students that a way to get an idea of the size of the solar system is by creating a model for it. Discuss with students other types of “models” that students are familiar with (model cars, rockets, globes, etc.)

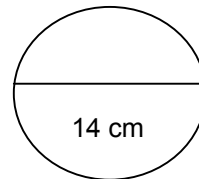
Discussion Questions:

What is a model?

Why do we use a model? (models allow us to explore things that are large, far away, or complex)

What is the scale of a model? (a model’s scale tells you how much bigger, smaller the real object is compared to the mode.

Blow up the yellow balloon until it is 14 cm in diameter.



Explain to students that this is going to be the model of the sun. Student pairs are going to observe how large the planets would be if the sun was actually this size. Students will compare the sizes of the planets they researched on the activity sheet for Learning Experience #4 in the Solar System Student Activity Book then discuss the appropriate models for each planet: Mercury & Mars (poppy seeds), Jupiter (gum ball), Saturn (mini-marshmallow or Kix cereal) Pluto (piece of black pepper), Venus & Earth (mustard seeds), Uranus & Neptune (popcorn kernel or pea seeds).

Learning Experience 4 continued

Page 2

Discussion Questions:

How do the planets compare with the sun?

What is the smallest planet of our solar system?

What is the largest planet?

How does the Earth compare to the other planets?

Are there planets that are close in size?

What surprised you about this learning experience?

Write the name of each planet on an index card. Inquire from students the correct position of the planets from the sun in our solar system. Explain to students that our focus is not the distance between the planets to scale at this time, only the order. Begin by taping the “sun” (large balloon) to the chalkboard or chart paper and then tape the cards in the order indicated by students. Use a reference book or internet source to check the order. Move the cards around as necessary to create the correct order of cards. Be sure you leave some room between the planets Mars and Jupiter. The asteroid belt will be drawn in this spot in Learning Experience #12. On their activity sheet for Learning Experience #4, students can also write in the names of the planets in order. Once the planets have been arranged correctly, label the inner (terrestrial) planets and the outer planets (gas giants) and discuss their differences in size. The outer planets are much bigger and farther apart than the inner planets. Pluto is difficult to classify because it is small, like the inner planets, but is at a farther distance away. Students will find out in later research, as well, that the inner planets have a rocky surface while the outer planets are made of gases.

As a class, think of a phrase that begins with the first letter of each planet that help students remember the order of the planets.

(ex. My Very Educated Mother Just Sat Upon Nick’s Parkbench = Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto)

Learning Experience 5: Distance Between Planets

Objective: Students will create a model of the distances between the planets of the solar system.

Materials:

For each student:

Solar System Student Activity Book

For the class:

10 metal stakes

Construction paper*

Meter stick*

Tape*

*provided by teacher

Preparation:

Read background information on pages 8-10,14-16. Map out an area of the schoolyard approximately 600 meters (as close to a straight line as possible) on the school grounds. Use construction paper to make a sign for the Sun and each planet. These signs are to be attached to a metal stake with tape. Those stakes will be used as markers for the planets.

Safety:

The metal ends of the stakes are sharp. Students should use caution if they are handling the stakes.

Basic Skills Development:

Creating Models

Comparing

Discussing

Gathering Data

Organizing Data

Evaluation Strategy:

Students will participate in creating a model of the distances between the planets of the solar system.

Vocabulary:

distance model

meter

double pace

How far are the planets from each other?

Now that the students have an idea of the size of the planets and how their size compares to our star, the sun, we are going to compare the distances between the sun and the planets. Look back at the research data on the distances between the sun and each planet for Learning Experience #3 and compare these distances.

Begin by demonstrating for students a “double pace.” A double pace is equal to taking two steps forward. The double pace is the ruler we are going to use to measure the distances, and it is equal to approximately one meter. You may want to choose a student to be the “pace setter” for the class – their double pace should be as close to one meter as possible.

Mark the location where you are starting as the sun. The metal stake with the sun sign on it should be placed in the ground there. Ask students what the next planet is (Mercury). Tell students the number of “double paces” to Mercury, from the Model Distance Chart on the page 33. They are to fill in their charts on their activity sheet for Learning Experience #5 in the Solar System Student Activity Book and as a class, “walk” to Mercury’s location. Place the stake with the Mercury sign on it at that location. Repeat the process for all the planets. Discuss with students that between the planets is mostly empty space. Also, discuss what students have learned about the distances in our solar system because of this walk.

Learning Experience 5 continued

Page 2

Model Distance Chart

Walking from:	Double paces (or meters) between planets in solar system model	Total distance from model sun to each Planet
Sun to Mercury	6 meters	6 meters
Mercury to Venus	5 meters	11 meters
Venus to Earth	4 meters	15 meters
Earth to Mars	8 meters	23 meters
Mars to Jupiter	55 meters	78 meters
Jupiter to Saturn	65 meters	143 meters
Saturn to Uranus	144 meters	287 meters
Uranus to Neptune	163 meters	450 meters
Neptune to Pluto	142 meters	592 meters

Discussion Questions:

What did you learn about the distances of the planets in the solar system? (The solar system is mostly empty space with huge distances between planets, our walking model is only one billionth the size of the actual solar system or 1 meter =10 billion meters in the real solar system.)

How have we on Earth learned so much about the planets? (telescopes, spacecraft)

How do the distances challenge spacecraft? (communication over vast distances, energy supply required for many years, equipment to withstand extreme cold)

How do the distances limit space exploration? (away from Earth for years, enough fuel, grow food)

What surprised you about this learning experience?

Remind students that planets never all line up to one side of the sun. They orbit the sun on different paths at different speeds. Some planets orbit in different planes. Students can refer to the picture on page 3 of their activity sheet for Learning Experience #4.

Learning Experience 6: Age On Other Planets

Objective: Students will calculate each planet's revolution around the sun in Earth days and use a formula to determine their age on each planet.

Materials:

For each student:

Solar Systems Student Activity Book
Calculator*

*provided by teacher/student

Preparation:

Read background information on pages 4 and 5.

Basic Skills Development:

Predicting
Gathering & Organizing Data
Discussing
Interpreting Data

Evaluation Strategy:

Students will calculate their age on other planets based on the length of that planet's revolution around the sun.

Vocabulary:

year
orbit
planet
outer planet
inner planet
revolution

How old would you be on another planet?

Ask students how old they are and list their ages on the chalkboard. Discuss how that age is determined. Our birthday is actually a celebration of a trip made by Earth around the sun one time. Each trip around our star = one year.

Students can examine the picture of the solar system on page 3 of their activity sheet for Learning Experience #4 and observe the orbit of the planets around the sun and relate that to the distance of the planets from the sun. Discuss how they believe their age would change based on the revolution of that planet around the sun.

Discussion Questions:

In comparing the Earth's location in the solar system and its revolution around the sun, on what planets do you think you would be "younger" or "older"? Explain.

How could you figure out your age on other planets?

On the activity sheet for Learning Experience #6 in the Solar System Activity Book, students will use the formula provided to figure out their age on the planets based on their revolution around the sun. Share ages and why their ages would change based on that planet's revolution around the sun.

Learning Experience 7: Weight on the Sun, Moon, and Planets

Objective: Students will make predictions on how their weight would differ on the moon and other planets and use a formula to determine what their actual weight would be on the moon and other planets.

Materials:

For each student:

Solar Systems Student Activity Book
Calculator*

*provided by teacher/students

Preparation:

Read background information on page 3. Students can be weighed in class or bring in their recorded weight from home. Students could also use an object's weight rather than their own to complete the activity sheet. A mini-lesson on comparing decimals may be needed for this learning experience.

Basic Skills Development:

Predicting
Discussing
Gathering Data
Organizing Data
Interpreting Data

Evaluation Strategy:

Students will compare the surface gravity on the sun, moon, and other planets to that of the Earth and calculate their weight on the sun, moon, and other planets.

Vocabulary:

weight
gravity
moon
planet
mass
force
planetary body

What would my weight be on the moon and on the other planets?

Discuss with students what they know about gravity and how gravity relates to our weight. It is the pull of the Earth's gravity that gives us weight.

Discussion Questions:

What is the relationship between gravity and the weight of the objects?

If the pull of gravity on one planet is different than that of Earth's, would our weight change if we went to that other planet?

How is weight different than mass?

Would our mass change if we went to another planet with a different pull of gravity? (no)

When astronauts are said to be weightless in space, what does that mean?

Can an astronaut be mass-less? (no, the astronaut would not exist)

Students are to look at the surface gravity's on the activity sheet for Learning Experience #7 in the Solar System Student Activity Book for the sun, moon, and the planets and complete the chart on the activity sheet. The chart asks students to compare the surface gravity of Earth to that of the planetary bodies listed and predict what their weight would be on the moon, the sun, and the other planets. Students are to then use a calculator to find their actual weight on that planetary body by multiplying their weight on Earth by the sun's, moon's, and planets' estimated surface gravity and graph their results.

Learning Experience 8: The Moon

Objective: Students will calculate the distance between scale models of the Earth and moon and demonstrate the rotation of the moon and its revolution around the Earth.

Materials:

For each student:

Solar Systems Student Activity Book

Calculators*

Metric rulers*

For the class:

Globe

2 #11 balloons

2 #5 balloons

2 pictures of the moon

Fishing line (50 cm.)

Plastic spool

Metric tape measure

1" bobber

Aluminum ball w/hook

*provided by teacher/student

Preparation:

Read background information on pages 3 and 4 and 9-12. A mini-lesson may need to be taught on finding the percentage difference between the diameter of two objects. You may need to ask students to draw a picture of the moon before this learning experience so it is available for discussion. The date of the full moon or gibbous moon can be found in newspapers and on various websites.

Basic Skills Development:

Discussing

Creating Models

Gathering & Organizing Data

Interpreting Data

Predicting

Measuring

Describing

Observing

How does the Earth and the moon compare?

To give students background information about the moon, ask students to think back to the learning experience when we simulated the size of the planets compared to the sun and distance between the planets of the solar system. Ask student to go back to the research data found in Learning Experience #3 to find the diameter of the Earth and the diameter of the moon and record their data. Then students are to find the percentage of the Earth's diameter and the moon's diameter using a calculator.

Moon's diameter in km = 3,476 km

Earth's diameter in km = 12,756 km

$$\frac{3,476}{12,756} = .27249$$

Therefore the moon's diameter is 27.25 percent of Earth's diameter.

Use the tape measure to find the diameter of the globe (23 cm). Students can record the diameter on the chart on their activity sheet for Learning Experience #8 in the Solar System Student Activity Book. Ask students to predict what diameter you would blow up a balloon to create a model of the moon if the Earth was the size of the globe. Actually, blowing up the balloon may help students visualize the size more clearly. Find the percentage for various predictions by dividing each prediction by the diameter of the globe. This learning experience can be completed in groups or as a whole class. Students can write the predictions and percentage size for each prediction on their activity sheets.

Learning Experience 8 continued

Page 2

Evaluation Strategy:

Students will compare the size of the moon to the Earth and will describe how the moon rotates and revolves around the Earth.

Students will demonstrate how gravity keeps the planets in orbit.

Vocabulary:

centrifugal force

centripetal force

diameter

revolution

gravity

rotation

model

$$\frac{6.3 \text{ cm}}{23 \text{ cm}} = .2739 \text{ or } 27.39 \text{ percent the size of the}$$

A balloon blown up to 6.3 cm in diameter would be very close to 27.25% we are looking for. Highlight the diameter size on the chart that is the closest to 27.25%.

When showing the distance between the two models, the scale model system is determined by setting the diameter of the globe equal to the diameter of the Earth.

Expressed simply, one centimeter in the model equals 554.6 km in space. $\frac{12,756 \text{ km}}{23 \text{ cm}}$

$$1 \text{ cm} = 554.6 \text{ km}$$

Using this scale, the distance between the globe and balloon blown up to 6.3 cm in diameter is found by dividing the average distance to the moon from Earth (382,000 km) by the scale (554.6 km).

$$X = \frac{382,000 \text{ km}}{554.6 \text{ km/cm}}$$

$$X = \frac{382,000 \text{ km} \text{ (cm/1)}}{554.6 \text{ km/cm} \text{ (cm/1)}}$$

$$X = \frac{382,000 \cancel{\text{ km}} \text{ (cm/1)}}{554.6 \cancel{\text{ km/cm}} \text{ (cm/1)}}$$

$$X = \frac{382,000 \text{ cm}}{554.6}$$

$$X = 688.8 \text{ cm}$$

That number can be rounded to 690 cm and converted to 6.9 meters. Going outside or in a long hallway, ask one student to hold the globe

Learning Experience 8 continued

Page 3

and ask another student or the rest of the class to complete 6.9 double paces (as done in Learning Experience #4) with the balloon blown up to 6.3 cm and discuss the results.

Discussion Questions:

Does the scale model of the moon and Earth distance fit our classroom, our hallway, our playground?

Is the moon closer to the Earth than you thought or farther away?

Is the size of the moon (balloon blown up to 6.3 cm in diameter) larger or smaller than you thought it would be in relation to Earth (globe)?

Session 2:

Begin a discussion on the moon's orbit by taking students outside or to the gymnasium to demonstrate how gravity acts on an orbiting object.

Tie a loop on one end of a 50 cm piece of fishing line and hook the bobber to that loop. Thread the other end of the fishing line through the center hole of thread spool. Tie a weight (aluminum ball with hook) to the other end of the string. With your right hand, hold the top spool and spin the bobber (the bottom loop is there only to keep the string steady).

Discussion Questions:

What is the relationship between the moon and the Earth?

Which object represents the Earth and the moon in this demonstration? (Bobber = moon, spool = Earth)

What keeps the moon orbiting around the Earth? (Earth's gravity)

Which part of the demonstration represents gravity? (String) What would happen to the bobber ("moon") if we let go of the string (no gravity)? What conclusion can you make? (Without the Earth's gravity, the moon would fly off into space.)

What do you think keeps the planets orbiting around the sun? (sun's gravity)

How does the sun's gravity compare to that of the other planets? (28x more than Earth, see Learning Experience #6)

Give other students the opportunity to try the activity. Students can compare this demonstration to the orbit of the moon around the Earth and explain their comparison on their activity sheet for Learning Experience #8 in the Solar System Student Activity Book. Be sure other students stay clear of the spinning bobber.

Session 3:

When a full moon or nearly full moon is available, ask students to draw an accurate picture of the moon and bring it to class. Discuss some of the features that they see. Pass around the pictures of the moon provided in this kit. One picture is of the full moon taken from Apollo 11 during its trip back to Earth, the other picture is one take by Apollo 16's metric image camera. Discuss with students which of the two pictures looks most like their picture of the moon. Students should find that the picture taken by Apollo 11 is most like their picture because the picture from the Apollo 16 mission shows the backside of the moon that we do not see.

Learning Experience 8 continued

Page 4

Discussion Questions:

What features did you notice when you looked at the moon?

What do you think these features are?

What picture looks most like your picture of the moon?

What features about the other picture look different than your picture?

The pictures/discussion should lead into the explanation that we only see one side of the moon due to the relationship between the moon's rotation and its orbit around the Earth. To be more specific, the moon turns once on its axis at the same time that it completes one orbit around the Earth. Therefore, the same hemisphere of the moon always faces us. A demonstration of this can be done by asking one student to sit in a chair and act as the Earth and ask another student to walk around the chair in a counterclockwise direction continually facing the chair. The person acting as the moon rotated once while revolving around the "Earth" once, just as the moon does. Notice how the same side of the student acting as the moon faced the student acting as the Earth. The students can then demonstrate what it looks like if the moon did not rotate on its axis. Without that rotation, the backside of the moon would be visible to "Earth". The student acting as the moon would walk around the chair keeping their head and body pointed in the same direction. Note the difference. The "moon" revolved around the "Earth" but did not rotate on its axis. The student groups that did research on the moon can provide information on how long it takes the moon to rotate and how long it takes for the moon to revolve around the Earth.

Moon's rotation period = period of orbital revolution (approximately 28 days)

One day on the moon = approximately 28 Earth days

Other students can try the rotation/revolution model with their partner to get a better understanding of the movement.

Discussion Questions:

Why can we only see one side of the moon?

What if the moon did not rotate?

Explain the demonstration we completed to your partner.

Learning Experience 9: Moon Phases

Objective: Students will model the phases of the moon and explain why these phases occur.

Materials:

For each pair of students:

2 Solar Systems Student Activity Books

5 cm (2") styrofoam ball

2 brass fasteners

Pencil*

5 index cards*

Scissors*

Glue*

For the class:

Lamp with no shade*

Extension cord (if needed)*

40 watt, 60 watt, or 75 watt clear bulbs*

Chart paper (optional)*

*provided by teacher

Preparation:

Read background information on page 10 -12. Before beginning this learning experience, determine which light bulb is best used in your classroom. Stand about the same distance from the lamp as the students will stand, hold the "moon ball" in your hand and move it to the left until you see a crescent. Observe the contrast between the light and dark sides of the ball for each bulb. Brighter bulbs provide more contrast for large rooms or if there is light coming from outside the room. Dimmer bulbs provide more contrast in small rooms with white walls. The moon balls will be used again in Learning Experience #10.

Why does the moon appear in different phases?

Ask student pairs to discuss the different ways they have seen the moon appear in the sky and to draw on index cards the different shapes or phases of the moon. Ask students to post their different cards on the chalkboard or on chart paper. Group similar pictures together and name each. (full, gibbous, half or quarter, crescent and new). If there is not a group for each phase of the moon, encourage a discussion of the missing type and add that card to the ones posted.

Discussion Questions:

What are the names of the different phases of the moon?

Is the lighted side of the moon facing toward or away from the sun (toward the sun)?

How long does it take for the moon to go from a full moon to the next full moon? (one month)

Ask students why the moon has phases and encourage different answers. Explain to students that they are going to model why the phases of the moon occur. Student pairs are to arrange themselves in a circle around the lamp. Hand out the 5 cm (2") styrofoam balls to each student pair. Students can push their pencil into the styrofoam ball, and the pencil will act like a handle for holding their "moon ball". One student from each pair is to hold their "moon ball" while the other student observes. Then the partners can switch places. Having only half the class complete the demonstration at a time helps with space, management, and students only have to complete one job at a time (demonstrating or observing). Explain that their head represents the Earth, the ball represents the moon, and the light represents the sun. The moon is now in its new moon phase. Ask students to hold the "moon ball" in front of them, directly in front

Learning Experience 9 continued

Page 2

Basic Skills Development:

Creating Models
Discussing
Observing
Describing

Evaluation Strategy:

Students will demonstrate and name the moon's phases and explain why these phases occur.

Vocabulary:

waxing
waning
waxing crescent
waning crescent
waxing gibbous
waning gibbous
new moon
full moon
first quarter moon
last quarter moon
phases
lunar
lunar cycle
model

of the sun. Then they are to move the ball a little to the left until they can see a thin crescent light up. Students will need to tilt their moon ball, similar to how the moon is tilted on its axis. When everyone can see the crescent, ask students to notice if the bright side of the moon is facing toward the sun or away from it? (toward the sun, like the real moon) Tell students who are in the demonstration to continue moving their moons around their heads in the same direction until half the moon is lit. Ask students if the moon is moving away from the sun or toward it to make the moon appear fuller? (away from the sun, just like the real moon). Tell students to continue moving the moon in a circle until it is fully lit. To do this, they will have to move the moon ball just above the shadow of their heads. Ask students to observe that when the moon is full, is it between you and the sun, or on the opposite side of you from the sun. Students should continue moving the moon in the same direction until they see the gibbous phase and then the half-full phase. Ask students that as the moon moves toward the sun, does it appear fuller or thinner? (Thinner) Finally, the moon appears again as a thin crescent. The moon, most of the time, does not pass directly in front of the sun but just above or below it. When there is a new moon phase the moon is between the Earth and the sun, and it is at the beginning of its lunar cycle. Ask students to switch positions so that the "observer" can try the demonstration. Once both students have completed the demonstration, they can complete the activity sheet for Learning Experience #9 in their Solar System Student Activity Book. Students can go through the demonstration as needed to help them order the moon phases on their activity sheet. Once students have ordered their phases discuss the names of each phase. Introduce the term "**waxing**" and "**waning**". Waxing means

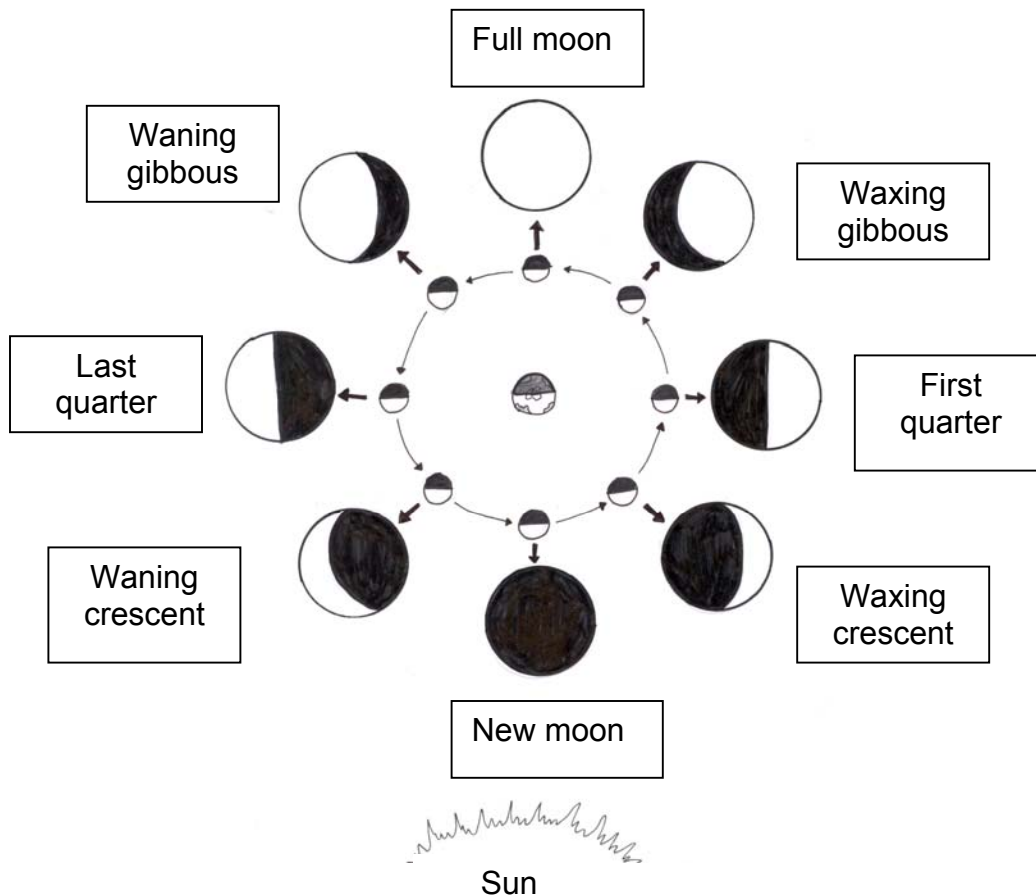
Learning Experience 9 continued

Page 3

growing (phases new to full) while waning means shrinking (phases full to new). Another way to think of it is the moon is in the “waxing” phase until the full moon, then it is in the “waning” phase to the new moon.

They are to use these terms when naming the crescent moon and gibbous moon. Students are to also title the quarter moons as first and last quarter. If the moon is lit on the right side it is in its first quarter and if it is lit on the left side it is in its last quarter.

Students can now keep a calendar of the moon phases for one month. Page 3 of the activity sheet for Learning Experience #9 has a calendar format available for students to draw the moon phases they observe each night. Identify the name of each phase in class discussion. The moon dial on pages 4 and 5 of the activity sheet will help students locate the moon’s position in the sky and the phase of the moon they will see. The directions for putting together the moon dial are stated on pages 4 and 5 of the activity sheet. Complete an in-class demonstration of how to use the moon dial.



Learning Experience 10: Eclipses

Objective: Students will demonstrate the position of the sun, Earth and moon during a solar and lunar eclipse and explain why they occur.

Materials:

For each pair of students:

5 cm (2") styrofoam ball
Pencils*

For the class:

Lamp with no shade*
45, 60 or 75 watt bulb*
Chart paper*
Felt tip markers*

*provided by teacher

Preparation:

Read background information on pages 3-5.

Basic Skills Development:

Observing
Describing
Discussing
Creating Models

Evaluation Strategy:

Students will demonstrate how a lunar and solar eclipse occurs and explain why it occurs.

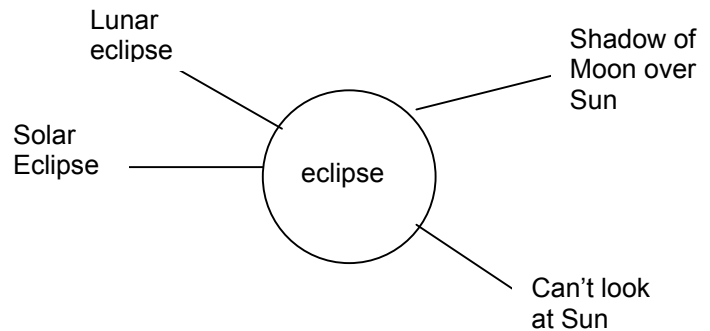
Vocabulary:

eclipse
moon
sun
solar
lunar
shadow
umbra
penumbra
model

What causes an eclipse of the sun?

What causes an eclipse of the moon?

Create a word web with students on their background knowledge of an eclipse.



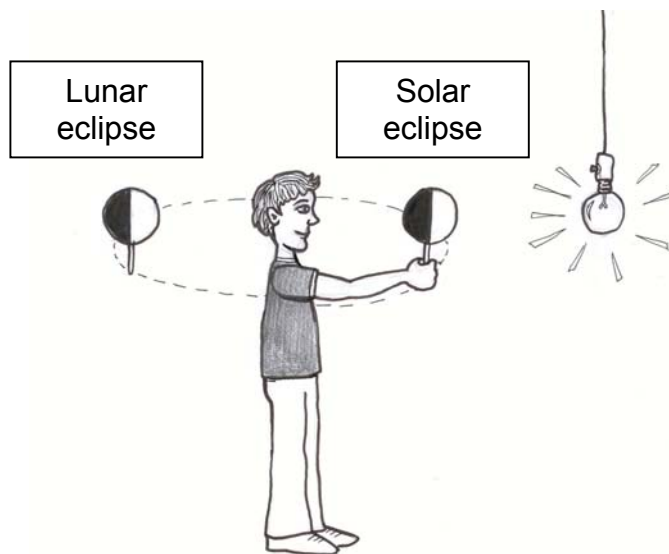
Review with students the rotation and revolution of the moon and Earth and Earth and sun. Explain to student that they are going to work with their partner to create a model of a solar eclipse and lunar eclipse. First, students are to again, form a circle around the lamp in the center of the moon. One student is to hold the moon ball while the other student observes. The observer's role is especially important in this learning experience because the person holding the moon ball cannot see the shadows that are important to observe. Students are to hold their "moon ball" directly in front of the sun. This will create an "eclipse of the sun." Remind students that their head is the Earth. The partner that is observing can now see the shadow over their partner's eyes. If you were living on this "Earth" at the location of your eyes you would be able to see this eclipse of the sun or solar eclipse. What about if people were living on your ear or chin? (they can still see the sun only people living on Earth where the moon's shadow falls can see the eclipse). Ask students to think back to the moon phases. In what phase would the moon be in during this solar eclipse? (new moon) This is due to the fact that when

Learning Experience 10 continued

Page 2

an eclipse occurs the moon is directly between the sun and the Earth and is positioned just right. Solar eclipses only occur during a new moon.

Next, instruct students to move their “moon balls” around in a circle, until they reach the full moon phase. This time tell them to move their moon into the shadow of their head. The student observing this will see the shape of the student’s head/hair when the “moon” moves into this eclipse position. This can also be demonstrated with two balls to show that when there is an eclipse of the real moon, one can see the shape of the Earth. It is round due to it’s curved shadow. Everyone that lives of the night side of the Earth during an eclipse of the moon can see it. Ask students to, again, think back to the moon phases. In what phase would the moon be in during the lunar eclipse (full moon). The Earth is positioned directly between the sun and the moon. Lunar eclipses only happen during the full moon. Students can try the demonstration again, and ask students to notice the phase the moon is in when an eclipse of the sun and an eclipse of the moon occurs. (During the month there is one time when there might be an eclipse of the moon (full moon phase) and one time when there may be an eclipse of the sun (new moon phase).



Learning Experience 11: Planetary Profile

Objective: Students will research a planet in the solar system and orally present their information to the class.

Materials:

For each pair of students:

2 Solar System Student Activity Books

Research materials (books, video, internet)*

Glue*

Metric ruler*

Preparation:

Read background information on pages 8 and 9, 14-16. How students will complete their research (individual, pairs, or small groups) will need to be decided prior to beginning this learning experience. Reference books on the planets may need to be gathered for use by students. Additional vocabulary may need to be addressed with student research material.

*provided by teacher

Basic Skills Development:

Describing

Discussing

Communicating

Evaluation Strategy:

Students will research a planet of choice and present research in an oral presentation.

Vocabulary:

research

planet

atmosphere

solar system

geological

exploration

galaxy

What do scientists know about the planets in our solar system?

In this learning experience, students are completing in-depth research on a planet in our solar system. Students could complete their research in small groups, pairs, or individually. If students are completing the research individually, directions on how to create a "book" to present their research information can be found on the activity sheet for Learning Experience #11 in the Solar System Student Activity Book. If student pairs or small groups are completing the research, then a multimedia presentation can be completed to include photos, illustrations, etc.

A variety of information could be collected on the planets.

- size of planet
- atmosphere
- geological traits
- number of moons and significant information on them
- exploration of the planet

Students or student groups could come up with the topics that interest them for their research.

Allow class time for each group to present its planet research. Include a class discussion so students can ask questions on the planets, which may prompt further research.

Learning Experience 12: Meteoroids, Meteors & Meteorites

Objective: Students will research the parts of the Earth's atmosphere and how it helps reduce meteorite impact, and by using a model of a meteor's impact on a surface, will illustrate a crater's structure.

Materials:

For each pair of students:

2 Solar System Student Activity Books
2 Crater Parts Identification sheets
3 sheets of 21.5 cm x 27.5 cm paper (8 ½ x 11)*
Glue*

For the class:

Picture of astronaut on the moon
Pictures of the farside of the moon
Glass marble (1")
Glass marble (½")
Metric tape measure
Trash bag
5 lb. container of sand
Dry tempera paint
Water bottle
Balance base
Balance arm
Balance stand
Pin for balance
2 baskets
Gram cubes
Modeling clay
Metric ruler*
Chart paper*
Felt tip markers*
Photocopy paper box lid*
Newspaper*
Water*

*provided by teacher

Preparation:

Read background information on pages 18 and 19. Create a model of the layered book to show students. An area of the room will need to be prepared with newspaper to reduce any mess caused by the "impact craters" in the sand.

How do asteroids and/or meteoroids alike effect the planetary bodies of the solar system?

Session 1:

Ask students to return to their picture of the planets of the solar system on the activity sheet for Learning Experience #4, and also, refer to the picture on the chart paper created in Learning Experience #4. Review information about the planets discussed but focus on the area between Mars and Jupiter. There is a belt here called the **Asteroid Belt** that is filled with pieces of rock. Ask students to draw this belt into their picture on page 4 of the activity sheet for Learning Experience #4 and draw this belt on the model of the solar system that is posted on chart paper/chalkboard. Discuss with students their knowledge of asteroids.

Discussion Questions:

What is an asteroid made of?
What do they look like?
How large are asteroids?
Do the asteroids in the Asteroid Belt orbit the sun? Explain.
Do you think these asteroids ever leave the belt?
When do you think that would happen?
Where do the asteroids go?
Do you think they affect the planets? How?
Do you think these asteroids break apart?
What are the fragments of asteroids called? (meteoroids)

List on the chalkboard or on chart paper the word meteoroids, meteor, and meteorite and ask students to define them, what do they think the differences are between them? Tell students they will come back to those definitions after completing the next activity, but are to keep thinking about each.

Learning Experience 12 continued

Page 2

Basic Skills Development:

Discussing	Describing
Predicting	Observing
Measuring	Inferring
Creating Models	

Evaluation Strategy:

Students will explain how a planet's atmosphere helps reduce crater impact and will illustrate and compare craters made with different objects.

Vocabulary:

raised rim	profile
floor	lunar
central uplift	atmosphere
walls	ejecta
rays	impact
crater	meteoroid
asteroid	meteor
meteorite	

Student pairs are to use their activity sheet for Learning Experience #12 to create a layered book that will act as a paper model of the layers of the Earth's atmosphere. Student pairs or small groups are to then research the layers of the atmosphere. Important information to include for each layer would be its location and size and how the layer they are researching helps the Earth. Discuss research as a class. Students should write their information on the appropriate flap in their layered book. What students will find is that the **thermosphere** breaks up meteors before they fall to Earth's surface. The friction caused when they hit the atmosphere creates heat and they burn up.

Discussion Questions:

Where is each layer of the atmosphere located?

How far does it extend above the Earth?

How do the layers help protect the Earth?

What is found in each layer?

How does the thermosphere help protect the Earth?

Do you think that any meteors ever get through the thermosphere?

If they do get through the thermosphere, what do those meteorites cause?

Refer back to the definitions created on meteoroids, meteor, and meteorite. Ask students if they are able to recognize any differences between them. Students should be able to recognize that there are rocks broken off from asteroids or planets in space (meteoroid), there are some meteoroids that go through the Earth's atmosphere and burn up (meteor), and finally, there are some meteors that make it to Earth and form craters on the surface (meteorite).

Learning Experience 12 continued

Page 3

If students are not sure why, ask them to think about our Earth and compare the two. The moon does not have an atmosphere as the Earth does. No atmosphere is there to break the sunlight into colors. Show students the picture of the backside of the moon itself and its surface. Students should then infer that without an atmosphere to protect it, meteorites hit the moon's surface that causes the craters on the surface. In addition, the troposphere, the layer of atmosphere closest to the Earth is where weather occurs. (wind, rain, etc.) These are agents of erosion so craters on the surface of the Earth are eroded away. The moon does not have wind or water to erode its surface, therefore, the craters remain and are quite visible.

Discussion Question:

Compare the Earth's sky to the moon's sky?

Why do we see only a black sky on the moon?

How does the atmosphere help our Earth in relation to the meteors and debris in space?

Look at the moon's surface, why do you think the craters are able to hit the moon's surface? (no atmosphere to protect it)

Is there any way the craters on the moon's surface would be eroded away? (no) Why or why not?

Look at the picture of the astronaut on the moon again, if there is no wind on the moon, why does the flag appear to be blowing? (see back of picture)

Pass the pictures of the farside of the moon around the classroom and ask students to observe the crater formations carefully. Ask students to describe those craters in their own words. Have students examine a diagram of a lunar impact crater on the Crater Parts Identification Sheet. Discuss each part of a crater (see word bank) and label the parts of a crater on the diagram.

Set up a surface that will allow students to create "craters" then observe their structure. Lay newspaper down on a table surface. Line the lid of the photocopy paper box with a trash bag. Fill the box with the 5 lb. container of sand. Wet the sand a little with the water bottle then pack and smooth the sand. Sprinkle a layer of the powdered tempera on the sand. Find the mass of each of the marbles provided using the balance scale and gram centimeter cubes. Hold the marble 30 cm above the surface of the sand then drop the large marble on the surface. Look for crater features- basin, raised rim, ejecta blanket (sand on colored surface), rays (material shot out at high velocity forming lines pointing away from the impact). These features can be measured in depth, diameter and length. Students are to make top and profile drawings of the "craters" made by the ball on their activity sheet for Learning Experience #12 and compare them. Another glass marble of a smaller size could also be used next. Its "crater" can then be compared to the large glass marble "crater." The same balls can then be dropped at different angles of impact, if the angle of impact is changed, then the rays will be concentrated and longer in the direction of impact. A more horizontal impact will show a skewed crater shape. Dropping the balls from different heights and speeds will also result in different formations. Students can also collect pebbles of different weight and or sizes and create craters with those pebbles and compare them. The sand and tempera can be mixed and resmoothed. A new layer of tempera can then be added. Remind students that in a real impact the object is destroyed or broken up into smaller pieces.

Learning Experience 13: Comets

Objective: Students will identify the parts of a comet and explain how the sun effects a comet's orbit.

Materials:

For each student:

Solar System Student Activity Book

For the class:

Kite string (3 or more strands 35 cm long)

Styrofoam ball (7 cm in diameter)

Bobber

Aluminum ball w/hook

T-pin

Fan or blowdryer*

Notebook*

*provided by teacher

Preparation:

Read background information on pages 16-18.

Basic Skills Development:

Creating models

Predicting

Discussing

Describing

Observing

Evaluation Strategy:

Students will identify the parts of a comet and then explain the effects of the sun on a comet's orbit.

Vocabulary:

comet

solar wind

solid

liquid

gas

sublimation

coma

nucleus

orbit

dust tail

gas tail

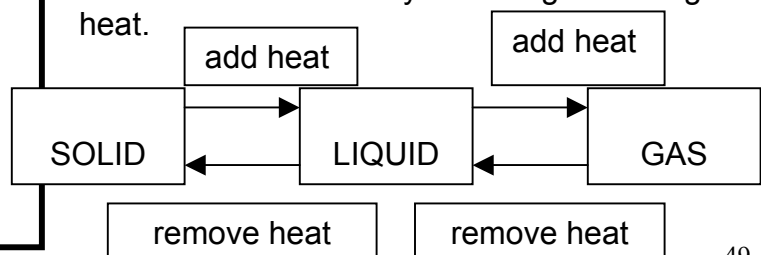
temperature

What are comets and how do they move through our solar system?

Ask students to draw what they think a comet looks like in their science notebook. Look for similar pieces to each student's drawing and discuss what some of the names of these parts could be. Students are to then label the diagram of the comet on the activity sheet for Learning Experience #13 in the Solar System Student Activity Book. Discuss each part of the comet and its formation (students could also complete research on this topic).

Ask students to then look at the picture on page 2 of their activity sheets. Explain to students that they are looking at an illustration of the orbit of Halley's comet. Students are to discuss with their partners what they observe from this picture and write their observations on their activity sheet. Students should notice the shape of the orbit (elliptical) and notice how it orbits the sun. Students should also remember from the activity done with centripetal forces that the sun's gravity is pulling the comet toward it in that orbit. Set up the activity with the bobber, string, and aluminum ball weight again and spin the bobber in a circle. This time as the bobber is spinning, push down on the weight below and ask students to observe what happens. What they should notice is that the ball spins faster. This illustrates what happens as the comet moves closer to the force of gravity of the sun – it speeds up.

Ask students to name the states of matter (solid, liquid, gas). Discuss how one changes from one to the other by removing or adding heat.



Learning Experience 13 continued

Page 2

In a comet, the material changes from a solid directly into a gas as it gets closer to the sun. This process of change from a solid to a gas is called **sublimation**. The heat from the sun causes the gaseous material around a comet that forms its well-defined tail. Therefore, comets traveling beyond Jupiter's orbit are usually tailless.

Ask students to think back to their research on the sun. The corona of the sun has energized particles escaping from it called the solar wind. The solar wind pushes back the particles in the comet's tail. Therefore, the comet's tail always pushes away from the sun. We often think of the comets tail showing us the direction it is moving, but it always points away from the sun regardless of the direction its moving.

Demonstrate this by using the 7 cm styrofoam ball and three or more pieces of kite string cut to 35 cm. Tie all the pieces of the kite string around the T-pin. Push the pin into the styrofoam ball. The ball represents the nucleus of the comet and the string represents the tail. Use a fan or blowdryer to represent the solar wind from the sun. Ask students to observe the comet's tail as it moves around the sun. Point the fan/blowdryer at the comet as it orbits around it. Notice the comet's tail always points away from it. Ask students to draw a picture that represents what Halley's comet looked like as it orbited the sun.

Discussion Questions:

What do you think will happen to the comet's tail as it moves around the sun?

How does the sun affect comets as they orbit them?

What would Halley's comet have looked like as it orbited the sun? Explain.

Students can do further research on famous comets such as Halley's, Hale-Bopp, Chiron, Hyakutake, Borrelly, etc. The NASA website lists the names of various comets discovered. Students could include in their research the comet's size, orbital period, how it was discovered, and who discovered it. Students will recognize that comets are named after the people that discovered them. Students may also discover that some comets barely get captured by the sun which results in an orbit that is uniquely shaped and sometimes they are captured by the gravity of planets rather than the sun, such as Jupiter or Saturn. If this occurs, it can alter the orbit of a comet which could hurl it into the sun or a planet. This occurred when the comet, Shoemaker – Levy 9 crashed into Jupiter.

Name: _____
Solar System Student Assessment

Date: _____

Directions: Read the question carefully and answer based on your knowledge about solar system. Circle the correct answer.

Use this picture to answer the first three questions.



_____ 1.) The Earth's spinning around its axis as shown in the drawing above is called:
1. revolution 2. revelation 3. phases 4. rotation

_____ 2.) How long does it take the Earth to spin around one time?
1. 365 1/4 days 2. 28 hours 3. 24 hours 4. 28 days

_____ 3.) Which of the following statements is true:
1. The Earth is one of the outer planets
2. The sun travels around the Earth
3. The Earth makes one revolution every 24 hours
4. The Earth is one of the inner planets

_____ 4.) Which of the following is in correct size from largest to smallest.
1. Sun - Earth - Mars - Jupiter
2. Sun - Mars - Earth - Jupiter
3. Sun - Jupiter - Mars - Earth
4. Sun - Jupiter - Earth - Mars

_____ 5.) What makes it possible for us to see the moon?
1. The Earth's light reflects off the moon
2. The Sun's light reflects off of the Earth
3. The Sun's light reflects off of the moon
4. The moon shines during the day

_____ 6.) Which of the following moon phases is called the full moon?



_____ 7.) Why can't you see the new moon?
1. The Sun's light is hitting the other side
2. The Earth's is having night time and its dark
3. The moon is hiding behind the sun
4. The Earth shadow is on the sun

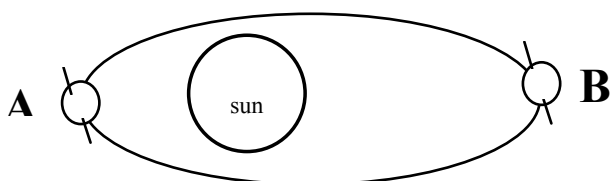
____ 8.) What can't we see during a lunar eclipse?

1. The moon
2. The sun
3. The Earth
4. The moon and the sun

9.) Below are the 4 phases of the moon. Draw each of them in the correct order as they actually happen.



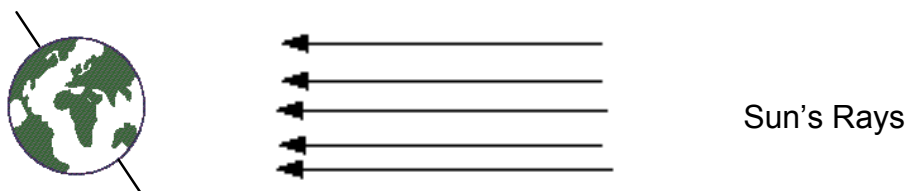
Use the drawing below to answer the following 2 questions.



10.) How long does it take the Earth to go from point A back around to point A again?

11.) What season is it when the sun is closest to the Earth?

Use the Drawing below to answer the next 2 questions.



12.) Who is having summer, North America or South America?

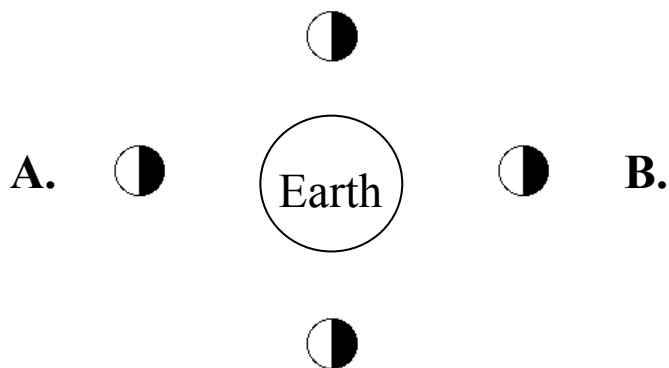
13.) Who is having the shortest amount of daylight, North or South America?

14.) Which planet has the greatest pull because of gravity?

15.) Your weight comes from your mass and gravity's pull. On which planet would you weigh the least?

Use the drawing below to answer the next 2 questions (16-17)

16.) Place an X where the sun belongs in the picture below.



17.) Which phase of the moon do we see at letter B?

Use the following chart to answer the next 3 questions (18-20)

Planet	Diameter of the planet (km)	Distance from the sun (millions of km)	Length of 1 revolution around the sun
Mercury	4,900	57.9	88 days
Earth	12,100	149.6	365 days
Jupiter	143,200	778.3	11.9 years
Mars	6,800	227.9	687 days

18.) Which planet has the longest time of revolution around the sun?

19.) What is a revolution?

20.) Which planet would likely be the coldest? Explain your answer.

_____ 21.) Which layer of the Earth's atmosphere breaks up meteors before they fall to Earth's surface?
 1. Stratosphere 2. Mesosphere 3. Thermosphere 4. Exosphere

_____ 22.) Which of the following has entered the Earth's atmosphere and started to burn and glow from friction?
 1. Meteoroid 2. Meteorite 3. Meteor 4. Meter

- _____ 23.) What is the center of the sun called?
1. Photosphere
 2. Chromosphere
 3. Corona
 4. Core
- _____ 24.) Which of the following is a true statement about a comet?
1. As it gets closer to the sun it gets hotter and slows down
 2. As it gets closer to the sun it gets hotter and speeds up
 3. As it gets closer to the sun it gets cooler and speeds up
 4. As it gets closer to the sun it gets cooler and slows down
- 25.) Think about how the size of a crater depends on the height of the impact. Write one complete sentence that explains how the size of the impact affects the size of a crater.

Solar System Student Assessment Key

1. 4
2. 3
3. 4
4. 4
5. 3
6. 4
7. 1
8. 1
- 9.
10. 365 1/4 days
11. Winter
12. South America
13. North America
14. Jupiter
15. Pluto
16. X is left of A.
17. Full moon
18. Jupiter
19. One complete path around the Sun
20. Pluto, it is the farthest away from the sun
21. 3
22. 3
23. 4
24. 2
25. The greater the impact the greater the size of the crater.



MORE IDEAS

Language Arts

- ♦ Research the meteorite crater in Winslow, Arizona.
- ♦ Write a story about a journey through the solar system.
- ♦ Write a story about what it would be like to live on the moon.
- ♦ Ask student groups to create a trivia game about the planets and then play the game.
- ♦ Debate whether or not we could or should colonize another planet.
- ♦ Write a science fiction story about a mission to Mars.

Book Suggestions: Stars and Planets by David Levy
1000 Facts About Space by Pam Beasant
Be Your Own Astronomy Expert by Guillaume Cannat
Comets by Samantha Bonas
Arty the Part Time Astronaut by Eddie Carbin
Earth by Robert Daily
The Earth in Space by Peter Riley
The Incredible Journey to the Planets: Close Encounters with Our Neighbors in Space by Nicholas Harris
Jupiter by Elaine Landau
Mars by Elaine Landau
Messages from Space: The Solar System and Beyond by Kevin Beals
Space Atlas by Heather Couper
Our Solar System by Seymour Simon
The Planets by Roy Gallant
The Sun and the Solar System by Arthur Upgren

Art

- ♦ Create a flip book of the moon phases.
- ♦ Create a collage of a planet from research done on a planet.

Science

- ♦ Make a model comet with dry ice. Recipes on how to do that are found on the challenger website. (www.challenger.org) in the Teacher's Guide titled The Theory of WOW.
- ♦ Research the various NASA spacecrafts that are collecting data about our solar system. Find out where the spacecrafts are traveling and what information they are collecting.
- ♦ Create a 3-D model of the solar system.
- ♦ Find out how dehydrated food is made and why this type of food is taken on space missions.
- ♦ Investigate the various star patterns in the sky (constellations) and find out when those constellations are found in the sky.
- ♦ Research the geology of the moon.
- ♦ Create a pinhole camera to observe the sun.

Math

- ♦ Plot/graph the sunrise and sunset daily and compare data.
- ♦ Calculate the distances to certain stars. Find out how they calculate distances in light years.

- ◆ Have students compute how long it would take them to travel to a given planet and return.

Social Studies

- ◆ Interview someone that remembers the Apollo moon landing. Discuss the history of that time period.
- ◆ Create a timeline of space history.

INQUIRY AND PROCESS SKILLS

Classifying	Arranging or distributing objects, events, or information in classes according to some method or system.
Communication	Giving oral and written explanations or graphic representations of observations.
Creating Models	Displaying information by means of graphic illustrations or other multi-sensory representations.
Formulating Hypothesis	Constructing a proposition or assumption of what is thought likely to be true based on reasoning, which serves as a tentative testable theory.
Gathering & Organizing	Collecting information about objects and events which show a specific situation.
Generalizing	Drawing general conclusions from information.
Identifying Variables	Recognizing the characteristics of objects or events which are constant or change under different conditions.
Inferring	Making a statement or conclusion based on reasoning or prior experience to explain an observation.
Interpreting Data	Analyzing information that has been collected and organized by describing apparent patterns or relationships in the information.
Making Decisions	Choosing an alternative from among several and basing the judgment on defensible reasons.
Manipulating Materials	Handling or treating materials, equipment or procedures skillfully and effectively.
Measuring	Making quantitative observations by comparing to a standard.
Observing	Becoming aware of an object or even by using any of the senses to identify properties.
Predicting	Making a forecast or estimate of what future events or conditions may occur.

GLOSSARY

Asteroid:	a rocky body orbiting the sun. Most asteroids orbit between Mars and Jupiter.
Atmosphere:	mixture of gases that surround a planet.
Axis:	the line about which a rotating body turns.
Central uplift:	mountains formed in the crater because of the large increase and rapids decrease in pressure during the impact event. They occur in the center of the craters that are larger than 40 km in diameter.
Centrifugal force:	the force repelling a body away from the axis around which distance through a sphere measured through the center of the sphere.
Centripetal force:	a force attracting a body toward the axis around which it rotates.
Chromosphere:	the gaseous surroundings of a star.
Comet:	small, icy solar system bodies with highly elliptical orbits around the sun.
Coma:	the bright large atmosphere that surrounds the nucleus of a comet.
Compare:	to examine for similarities and differences.
Constellation:	a pattern of stars in the sky named for a person, animal, or object. Astronomers use constellations to decipher directions in space.
Contrast:	to compare to show differences.
Convection zone:	the layer on the sun where the heat from the core is transferred by the circulation of the heated parts to the surface.
Core:	the central layer of the sun.
Corona:	a white or colored circle.
Crater:	a hole or depression that is often circular or oval in outline. 37
Diameter:	the distance across and through its center. The distance through a sphere measured through the center of the sphere.
Distance:	the extent of space between two points.
Double pace:	two steps forward.

Dust tail:	tail of a comet composed of dust blown from the comet as it nears the sun. This dust “shines” by reflecting sunlight.
Eclipse:	blocking all or part of the light from one object by another.
Ejecta:	blanket of material surrounding the crater that was out from and deposited during impact event. Ejecta becomes thinner away from the crater.
Equinox:	either of the two instances when the sun is directly over the Earth’s equator (March 21 – vernal equinox, September 21 – Autumnal Equinox). The length of day and night at the time of the equinoxes are nearly equal all over the world.
Exploration:	to traverse through a region for the purpose of discovery.
First Quarter Moon:	the phase of the moon when the right half of the moon appears lighted and the left side of the moon appears dark.
Floor:	bowl shaped or flat portion of the crater characteristically blows the surrounding ground level unless filled with lava.
Force:	an influence on a body or system that produces a change in movement or shape.
Full Moon:	the phase of the moon when the full lighted side of the moon faces the Earth. The Earth, sun, and moon are nearly in straight line in this phase.
Galaxy:	a large number of stars and vast amounts of gas held together by their gravity.
Gas:	the state of matter that has no definite shape and takes up no definite amount of space, must be moving to be felt, and takes the size and shape of its container.
Gas tail:	the material streaming off a comet composed of ions blown straight behind the comet by the solar system. 38
Geological:	the features and processes occurring in a region on Earth or a celestial body.
Gravity:	the force of attraction.
Inner planet:	planets in our solar system that are rocky, smaller in size, and closer to the sun. (Mercury, Venus, Earth, Mars)
Impact:	the forceful striking of one body (meteorite), against another body, like a moon or planet.

Last Quarter Moon:	the phase of the moon when the left half of the moon appears lighted and the right side appears darks.
Liquid:	the state of matter that has no definitely shape, but takes up a definite amount of space, feels wet, and takes the shape of its container.
Lunar:	pertaining to the moon.
Lunar cycle:	revolution of the moon around the Earth. This revolution results in phases that occur every 28 days, from new moon to new moon
Mass:	the amount of matter in an object, measured in grams.
Meteor:	the meteoroid entering the Earth's atmosphere, which starts to burn and glow from the friction.
Meteoroid:	the rocky/metallic objects found in the asteroid belt that may enter our atmosphere.
Meteroite:	pieces of a meteor that survives through a planetary body's atmosphere and makes an impact.
Meter:	fundamental unit of length in the metric system.
Model:	representation of something really large or small at a size we can explore. It has specific characteristics of the real object(s).
Moon:	a small body that orbits the planet.
New Moon:	the phases of the moon when the moon is on the same side of the Earth as the sun is and we see only the part of the moon that is in shadow.
Nucleus:	the core of a comet usually consisting of various ices and dust. Just a few kilometers across the nucleus it can be composed of water, carbon dioxide, and ammonia.
Orbit:	a curved path that a celestial body takes around another.
Outer planet:	gaseous planets that include Jupiter, Saturn, Uranus, Neptune, and Pluto
Photosphere:	the surface of the sun.
Planet:	a major object that orbits around a star.

Planetary body:	any large, heavenly body revolving around the sun and shining by reflected light.
Phases:	one of the appearances or states of the moon, its illumination.
Prenumbra:	the partial shadows surrounding the complete shadow of an opaque body during an eclipse.
Profile:	an outline of an object.
Radiation zone:	the energy from the core of the sun passes through this layer. Energy is transformed into X-rays, ultraviolet light, and visible light.
Raised rim:	rock thrown out of the crater and deposited as a ring of debris at the crater's edge during the explosion and excavation of an impact event.
Rays:	bright streaks that blasted out and extending away for great distances from an impact crater.
Research:	inquiry into a subject in order to discover or check facts.
Revolution:	movement in a circular path or orbit.
Rotation:	turn on an axis or centerpoint.
Shadow:	a dark image cast on a surface by a body intercepting light.
Solar:	pertaining to the sun.
Solar flares:	plumes of energy released by the sun that send atomic particles, X-rays, and other energy outward into the universe.
Solar system:	the sun and the group of celestial bodies
Solid:	the state of matter that has a definite shape and takes up definite space.
Solstice:	either of the two instances during the year when the sun as seen from Earth is farther and north or south of the equator. Summer Solstice (June 21 st) find the sun over the Tropic of Cancer and in the Winter Solstice (December 21 st) the sun is over the Tropic of Capricorn.
Sphere:	a round body such as a ball, globe, or planet.
Star:	a large hot ball of gas that generates energy from its core by nuclear reactions.

Strategy:	a detailed plan for reaching a goal.
Sublimation:	the process of a solid changing into a gas.
Sun:	the star that is the central body of the solar system around which the Earth and other planets revolve and from which they receive light.
Sunspots:	cool spots on the surface of the sun that appear as dark spots.
Temperature:	the measure of warmth or coldness of an object.
Umbra:	the central portion of the shadow of a celestial body where the light from the source of illumination is completely cut off.
Walls:	steep sides of the crater. Some may have great stairs called terraces.
Waning:	decreasing of illumination.
Waning crescent:	the phase of the moon that occurs after the Last Quarter, Moon and before the New Moon.
Waning gibbous:	the phase of the moon that occurs after the Full Moon, but before the Last Quarter Moon.
Waxing:	increasing of illumination.
Waxing crescent:	the phase of the moon that occurs after the New Moon and before the First Quarter Moon
Waxing gibbous:	the phase of the moon that occurs after the First Quarter Moon but before the Full Moon.
Weight:	the measure of gravitational pull on an object.
Year:	the period of time, 365 $\frac{1}{4}$ days, in which the Earth makes a complete revolution around the sun.

TEACHER REFERENCES

Out of This World. AIMS Activities. 1994.

Nature Scope – Astronomy Adventures, National Wildlife Foundation. 1989.

Williams, Jack. The Weather Book. Vintage Books. 1992.

Media Library

Call the media library to order media materials and to check on new materials that are available. The number to be reached is (716) 376-8212.

Web Sites

<http://www.education.noaa.gov>

<http://www.nasa.gov>

<http://school.discovery.com/lessonplans/programs/planetaryprofiles/index.html>

<http://www.windows.ucar.edu>

<http://www.explorezone.com/space/sun.htm>

<http://www.comets.amsmeteors.org/educate/comintro.html>

<http://sunEarth.gsfc.nasa.gov/eclipse/extra/TLE2001Jan09.html>

<http://www.challenger.org>

<http://www.exploratorium.edu/ronh/solar-system/index.html>