Earth Science 8

March 23-27

Time Allotment:30 minutes per day

Student Name: ___________________________________

Teacher Name: ___________________________________

Earth Science 8: The Solar System
March 23-27

Packet Overview

Date	Objective(s)	Page Number
Monday, March 23	1. Express the defining characteristics of the 4 inner planets and their relative locations.	2
Tuesday, March 24	1. Express the defining characteristics of the 4 outer planets and their relative locations.	9
Wednesday, March 25	1. Explain the theorized reasons for the characteristics of each planet based on the leading theory of solar system formation.	15
Thursday, March 26	1. Explain the cycles of day and night, the 4 seasons, and the lunar cycle.	19
Friday, March 27	1. Explain how tides work in relation to the lunar cycle.	25

Additional Notes: Students are to designate a specific location in their home for their workspace to learn about Earth and Space.

This could be a table or desk anywhere in the home that could be labeled their school zone. By doing so, the students will have a stable work environment that they will keep all of their learning materials organized, they can visit, and take a rest from.

Academic Honesty

I certify that I completed this assignment independently in accordance with the GHNO Academy Honor Code.

Student signature:

____

I certify that my student completed this assignment independently in accordance with the GHNO Academy Honor Code.

Parent signature:

____

Monday, March 23

Unit: Astronomy

Unit Overview

The Greek Platonist philosopher Proclus Lycaeus the Successor (412-485 AD) wrote of the four classical liberal arts that:

> "The Pythagoreans considered all mathematical science to be divided into four parts: one half they marked off as concerned with quantity, the other half with magnitude; and each of these they posited as twofold. A quantity can be considered in regard to its character by itself or in its relation to another quantity, magnitudes as either stationary or in motion. **Arithmetic**, then, studies quantities as such, **music** the relations between quantities, **geometry** magnitude at rest, and **astronomy** magnitude inherently moving."

Astronomy (from the Greek ἀστρονομία/astronomia, meaning "law of the stars") then has been understood as one of the foundational areas of study for mankind and an essential part of any complete education. Pythagoras distinguished between *quantity* and *magnitude*. Objects that can be counted give whole numbers. Substances that are measured provide magnitudes. Cars are counted while gasoline is measured- I cannot really have half a car, but I can have half a gallon of gasoline. Arithmetic studies quantities or numbers; music involves the relationship between numbers and their expression in time (think of concepts like the circle of fifths, octaves, time signatures, etc); geometry deals with magnitudes; astronomy deals with those magnitudes' distribution in space through time.

Perhaps this seems strange to our modern ears- isn't astronomy just the study of objects in outer space like stars and planets? But the ancients, working without the benefit of modern telescopes and radio observatories and the like, were keenly aware of what is the most distinctive feature of the cosmos as it presents its wandering stars to our wondering eyes- it is somehow simultaneously *unchanging* (the constellations we see- and which you will learn- each night are the same seen by any farmer or king or prophet 5,000 years ago) while also being constantly in *motion*. The stars move through their courses over the hours of the night, the constellations visible in January are not those that are visible in June, and those pesky wandering stars- the planets- move in relation to the fixed stars every single night before ultimately returning to where you had first observed them- and they return there after a mathematically precise amount of time.

Over the course of this unit we will begin with what is nearest to us- our solar system. A solar system within which we inhabit a relatively small and as far as we are currently aware utterly unique blue and green rock hurtling around a fairly typical star at just under 67,000 mph. From there we will move outward to the stars and nebula which make up our Milky Way Galaxy, and finally to the intergalactic void and the very structure of the cosmos itself.

Lesson 1: Monday, March 23:

Solar System Introduction and the Four Inner Planets.

Objective: Be able to do this by the end of this lesson:

1. Describe key features of each of the inner planets.
2. Compare each of the inner planets to Earth and to one another

Key terms:

Solar System: the collection of eight planets and their moons in orbit around the sun, together with smaller bodies in the form of asteroids, meteoroids, and comets.

Astronomical Unit: A unit of **distance** used to simplify the vast distances between objects in the solar system. Equal to the **average distance of the Earth from the Sun,** or about 93 million miles. Therefore, the distance from the Earth to the Sun can be expressed as **1 Astronomical Unit,** or, more commonly **1 AU.**

Planet: - a celestial body that:
1. Directly orbits the Sun (or other star) and NOT orbiting any other object in its solar system.
2. Has sufficient mass for its own gravity to force it into a spherical shape.
3. Has “cleared the neighborhood” around its orbit.

(This third definition remains controversial. What does it mean to ‘clear the neighborhood’? Imagine a huge ship like an ocean liner or aircraft carrier careening forward- imagine that in its path are a large number of small free-floating buoys and dinghies and other small floating objects. What will happen as the huge ship plows through the smaller objects? They will be either destroyed or pushed aside so that the path behind the large ship is now clear. If an object in the solar system is massive enough to push every other smaller object out of its orbital path it has ‘cleared the neighborhood.’ This, by the way, is why Pluto is no longer considered a planet).

Dwarf Planet: Fulfills definitions 1 and 2 seen above, but not 3.

Asteroid: Fulfills definitions 1 seen above, but **neither** 2 **or** 3.

Moon: Also known as a **Natural Satellite-** an astronomical body that orbits a planet or minor planet

Comet: Similar to an asteroid, a comet is a celestial object consisting of a **nucleus of ice and dust** (a ‘dirty snowball’) and, when near the sun, a “tail” of gas and dust particles pointing away from the sun.

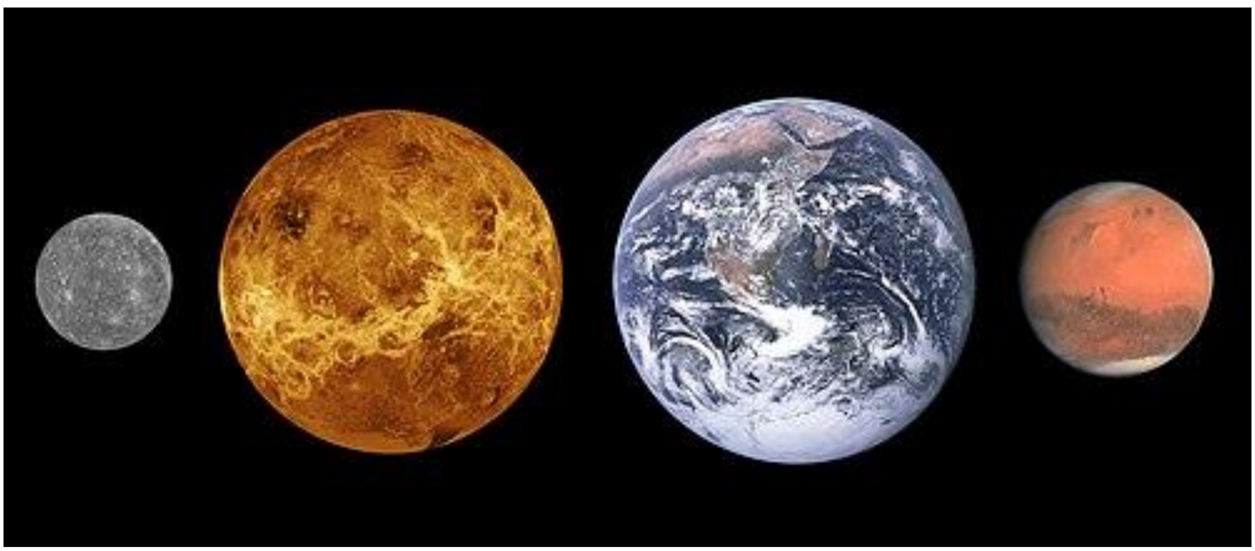
Meteoroid: much smaller rocks or particles (compared to an asteroid or a comet) in orbit around the Sun.

Meteor: If a meteoroid enters the Earth's atmosphere and vaporizes, it becomes a meteor, which is often called a shooting star.

Meteorite: If a small asteroid or large meteoroid survives its fiery passage through the Earth's atmosphere and lands on Earth's surface, it is then called a meteorite.

The Four Inner Planets

The four planets closest to the sun—**Mercury, Venus, Earth and Mars**—are the **inner planets**, also called the **terrestrial planets** because they are similar to Earth (Latin: Terra). The figure below shows the relative sizes of these four planets. All of the inner planets are small when compared to the **outer planets**. All of the inner planets are **solid**, **dense**, **and rocky**. The inner planets either do not have moons or have just one (Earth) or two (Mars). None of the inner planets have rings. Compared to the outer planets, the inner planets have shorter orbits around the Sun (shorter **years**).



Mercury Venus Earth Mars

Mercury is the planet closest to the Sun. Mercury is the **smallest planet**, and it has **no moon**. Similar to the Earth's moon, Mercury is covered with craters. This suggests that mercury has **not had any geologic activity** (like earthquakes or volcanoes) for millions and millions of years, as those events would eventually disrupt or cover the ancient craters. The presence of the craters also suggests that the planet either has **either never had or has not recently had any atmosphere**- weather effects like rain and wind would have eroded, or worn away, the craters over time.

Mercury's **year**- how long it takes for it to fully orbit the sun once- is 88 earth days long.

Mercury's **day-** how long it takes for it to fully rotate once on its axis- is a grindingly slow 58 earth days long. Therefore, a year on mercury is only a day and a half long.

Mercury's **distance** from the sun- Though all planets have slightly elliptical (elongated) orbits, they are nearly circular. Mercury is on average appx. 42.6 million miles from the Sun.

CHECK: how many Astronomical Units is Mercury from the Sun? _________

Venus is the **second plan**et from the Sun, and is the planet that gets closest to the Earth. It is the **brightest planet** when seen from Earth, and the **third brightest object seen in the sky** behind the Sun and the Moon. Viewed through a telescope, Venus looks smooth and featureless. That's because Venus is covered by a thick layer of clouds, a result of its **very dense atmosphere.**

Unlike clouds on Earth, Venus's clouds are not made of water vapor. They are made of **carbon dioxide and sulfur dioxide**—and they also contain large amounts of corrosive sulfuric acid.

The atmosphere of Venus is so thick that the **atmospheric pressure on the surface of Venus is 90 times greater than the atmospheric pressure on Earth's surface.** The thick atmosphere also causes a strong **greenhouse effect**, which traps heat from the Sun. As a result**, Venus is the hottest planet**, hotter than Mercury even though that planet is closer to the Sun. Temperatures at the surface reach 465°C (860°F).

Venus has **no moon.**

Venus is the **only planet that rotates clockwise** as viewed from its North pole, in a direction opposite to the direction it orbits the Sun.

Venus's day is very long, making one turn every 243 days.

This is longer than a **year on Venus-** it takes Venus only 224 days to orbit the Sun.

Venus's distance from Sun- approximately 66.8 million miles from the Sun.

CHECK: how many Astronomical Units is Venus from the Sun? _________

The Earth is **the 3rd planet from the Sun** and our dear home. The **only known home to life of any kind anywhere in the universe**, the planet has a number of features which distinguish it in astronomical terms.

The Earth has **vast oceans of liquid water, large masses of land**, **ice covering the poles**, and a **dynamic atmosphere with clouds of water vapor**. Earth's average surface temperature is 14°C (57°F). As you know, water is a liquid at this temperature. Due to the greenhouse effect and phenomena we recently studied such as ocean breezes, the oceans and the atmosphere help keep Earth's surface temperatures fairly steady.

As mentioned above, the Earth is the only planet known to have life. The conditions on Earth, especially the presence of liquid water, are ideal for life as we know it. The atmosphere filters out radiation that would be harmful to life, such as ultraviolet radiation and X rays. The presence of life has changed Earth's atmosphere, so it has much more oxygen than the atmospheres of other planets. The most important reason for the Earth's habitability is that it lies in what is known as **The Goldilocks Zone-** it is within a small range of distances from the Sun (also known as the '**circumstellar habitable zone**') that is neither too hot nor too cold for life- but ***just right.***

The top layer of Earth's interior—the crust—contains numerous plates, known as tectonic plates. These plates move on the convecting mantle below, so they slowly move around on the surface. Movement of the plates causes other **geological activity**, such as earthquakes, volcanoes, and the formation of mountains. **Earth is the only planet known to *currently* have geologic activity.** We will explore this activity in MUCH greater depth in an upcoming unit.

The Earth's **day** is, of course, 24 hours, it's **year** is 365 days, and it orbits the Sun at an average distance of **93,000,000 miles**. It has 1 moon, The Moon, sometimes known by its **Latin name 'Luna'** to distinguish it from other moons in the solar system.

CHECK: how many Astronomical Units is the Earth from the Sun? _________

Mars is the fourth planet from the Sun, and the first planet beyond Earth's orbit. The **Martian atmosphere** is thin relative to Earth's and with much lower atmospheric pressure. Unlike Earth's other neighbor Venus, Mars has only a weak greenhouse effect, which raises its temperature only slightly above what it would be if the planet did not have an atmosphere.

Although Mars isn't the closest planet to Earth (that, again, would be Venus), its relative proximity and thin atmosphere make it the easiest to observe. Therefore, **Mars has been studied more thoroughly than any other planet besides Earth**. Humans have sent many probes/robots/satellites to Mars. No humans have ever set foot on Mars. However, both NASA and the European Space Agency have set goals of sending people to Mars sometime between 2030 and 2040.

Viewed from Earth, **Mars is reddish in color**. This is **due to large amounts of iron in the soil-** this iron is chemically bonded with oxygen, making **Iron Oxide**- better known as rust. **Mars is rusty**. Mars' thin atmosphere is made up **mostly of carbon dioxide.**

Mars is home to the **largest mountain in the solar system**—**Olympus Mons**. Olympus Mons is about 27 km (16.7 miles/88,580 ft) above the normal Martian surface level. That makes it more than three times taller than Mount Everest. This extinct volcano means that Mars **once had geologic activity, but no longer does.**

Mars also has the **largest canyon in the solar system, Valles Marineris**. This canyon is 2,500 miles long, as wide as Europe, and is one-fifth the circumference of Mars. The canyon is 4.3 miles deep. By comparison, the Grand Canyon on Earth is only 277 miles long and about 1.2 miles deep. This canyon, like those on Earth, appears to have been created by vast amounts of running water- this means that **Mars likely once had large amounts of running water-** perhaps even the **conditions for life.**

Though there is no consistently liquid water on Mars, there are vast stores of frozen ice at the poles and perhaps buried beneath the surface.

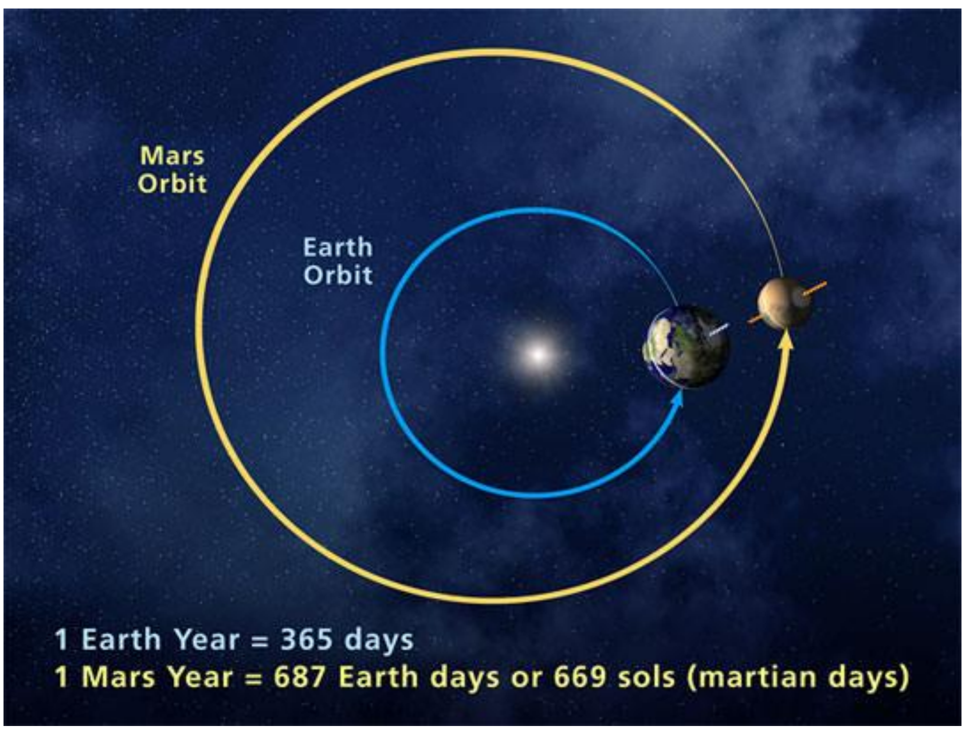
Mars has two very small moons, **Phobos and Deimos**. They are named after characters in Greek mythology—the two sons of Ares, who followed their father into war. Ares is equivalent to the Roman god Mars.

Mars' **year** is 687 Earth days long.

Mars' **day** is 24 hours and 37 minutes.

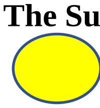
On average, Mars is **142 million miles** from the Sun.

CHECK: how many Astronomical Units is Mars from the Sun? _________



In the space below, draw and label a scale model of the **<u>inner solar system</u>**. The distance from the Earth to the sun, 93 million miles or 1 Astronomical Unit, is equal to 2 inches. Next to each planet write 2 distinct facts about it.

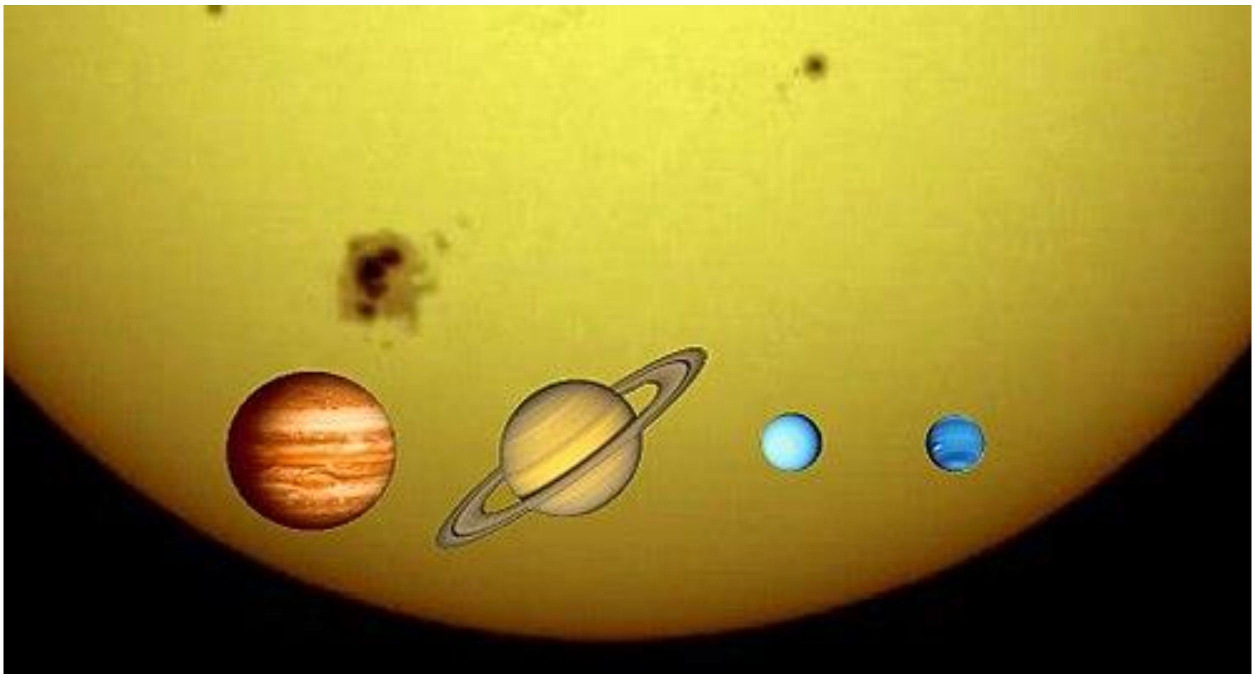
The Sun



Tuesday, March 24
Lesson 2: The Four Outer Planets

The Four Outer Planets

The four planets farthest from the sun—Jupiter, Saturn, Uranus, and Neptune—are called the outer planets of our solar system. Their relative sizes compared to the Sun are shown below. Because they are **much larger than Earth and the other inner planets**, and because they are **made primarily of gases and liquids rather than solid matter**, the outer planets are also called **gas giants.**



Jupiter Saturn Uranus Neptune

The gas giants are made up primarily of **hydrogen and helium**, the same elements that make up most of the Sun. Astronomers believe that hydrogen and helium gases were found in large amounts throughout the solar system when it first formed. However, **the inner planets didn't have enough mass to hold on to these very light gases**. As a result, the hydrogen and helium initially on these inner planets floated away into space. Only the Sun and the massive outer planets had enough gravity to keep hydrogen and helium from drifting away.

All of the outer planets have **numerous moons.** All of the outer planets also **have planetary rings**, which are rings of dust and other small particles encircling a planet in a thin plane. Only the rings of Saturn can be easily seen from Earth.

But before we go any further to the gas giants, we must take a brief visit at…

The Asteroid Belt

Asteroids are very small, rocky bodies that orbit the Sun. "Asteroid" means "star-like", and in a telescope, asteroids look like points of light, just like stars. Asteroids are also sometimes called planetoids or minor planets, because in some ways they are similar to miniature planets. Unlike planets, though, asteroids are irregularly shaped because they do not have enough gravity to become round like planets. They do not have atmospheres, and they are not geologically active. The only geological changes to an asteroid are due to collisions, which may break up the asteroid or create craters on the asteroid's surface.

Hundreds of thousands of asteroids have been discovered in our solar system. They are still being discovered at an astonishing rate of about 5,000 new asteroids per month. **The majority of the asteroids are found in between the orbits of Mars and Jupiter, in a region called the asteroid belt**. Although there are many thousands of asteroids in the asteroid belt, their total mass adds up to only about **4**% of Earth's moon.

Scientists believe that the bodies in the asteroid belt formed there during the formation of the solar system. However, **they have never been able to form into a single planet because the gravity of Jupiter, which is very massive, continually disrupts the asteroids.** In other words- Jupiter 'cleared the neighborhood).

J**upiter** is the **largest planet** in our solar system, and the largest object in the solar system besides the Sun. Jupiter is named for the king of the gods in Roman mythology. Jupiter is truly a giant. It is much **less dense** than Earth—it has **318 times the mass of Earth**, but over 1,300 times Earth's volume. Because Jupiter is so large, it reflects a lot of sunlight. When it is visible, it is the brightest object in the night sky besides the Moon and Venus.

Like all gas giants, Jupiter is mad**e mostly of hydrogen, with some helium, and small amounts of other elements**. The outer layers of the **planet are gas**. Deeper within the planet, pressure compresses the gases into a liquid. Some evidence suggests that Jupiter may have a **small rocky core at its center.**

The upper layer of Jupiter's atmosphere contains clouds of ammonia (NH3) in bands of different colors. These bands rotate around the planet, but also swirl around in turbulent storms. The **Great Red Spot**, visible in the southern hemisphere of Jupiter in the image above, is an enormous, oval-shaped storm found south of Jupiter's equator. It is more than three times as wide as the entire Earth. Clouds in the storm rotate in a counterclockwise direction- due to our old friend the Coriolis Effect- making one complete turn every six days or so. The Great Red Spot has been on Jupiter for at least 300 years. It is possible, but not certain, that this storm is a permanent feature on Jupiter.

Jupiter has a very large number of moons. We have discovered over 60 **natural satellites** of Jupiter. Of these, four are big enough and bright enough to be seen from Earth, using nothing more than a pair of binoculars. **These four moons—named Io, Europa, Ganymede, and Callisto—**were **first discovered by Galileo** in 1610, so they are known as the **Galilean moons**.

The image below shows the four Galilean moons and their sizes relative to the Great Red Spot. The Galilean moons are larger than the dwarf planets Pluto, Ceres, and Eris. In fact, Ganymede, which is the biggest moon in the solar system, is even larger than the planet Mercury.

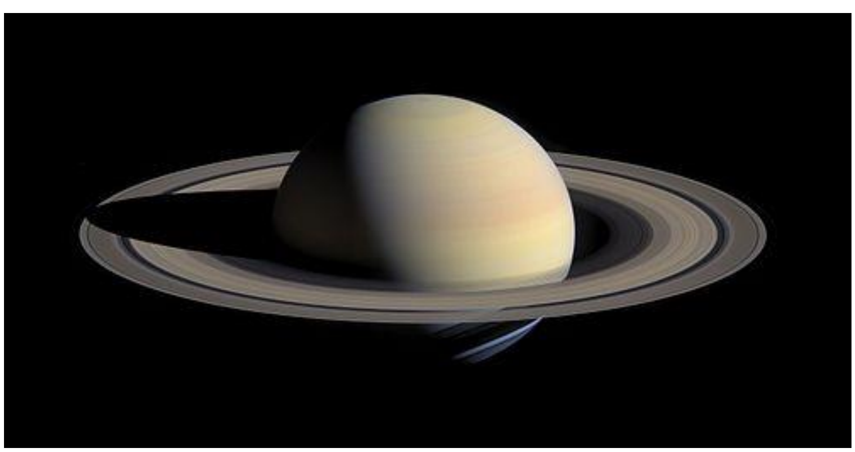
Jupiter is on average **483.5 million miles** from the Sun.

Jupiter's **year** is approximately 12 Earth years.

Jupiter's **day** is just under 10 hours(!)

CHECK: how many Astronomical Units is Jupiter from the Sun? _________

Saturn, below, is famous for its beautiful rings. Saturn's mass is about **95 times the mass of Earth**, and its **volume is 755 times Earth's volume**, making it the **second largest planet** in the solar system. Despite its large size, Saturn is **the least dense planet** in our solar system. It is less dense than water, which means if there could be a bathtub big enough, Saturn would float. In Roman mythology, Saturn was the father of Jupiter. So, it is an appropriate name for the next planet beyond Jupiter.



Saturn's composition is similar to Jupiter. It is made mostly of **hydrogen and helium**, which are gases in the outer layers and liquids at deeper layers. It may also have a small solid core. The upper atmosphere has clouds in bands of different colors. These rotate rapidly around the planet, but there seems to be less turbulence and **fewer storms on Saturn than on Jupiter.**

The **rings of Saturn** were first observed by Galileo in 1610. However, he could not see them clearly enough to realize they were rings; he thought they might be two large moons, one on either side of Saturn. In 1659, the Dutch astronomer **Christiaan Huygens was the first to realize that the rings were in fact rings, not moons**. The rings circle Saturn's equator. They appear tilted because Saturn itself is tilted about 27 degrees to the side. The rings do not touch the planet.

In the early 1980s, the Voyager probes sent back detailed pictures of Saturn, its rings, and some of its moons. From the Voyager data, we learned that Saturn's **rings are made of particles of water and ice, with a little bit of dust as well.** There are several gaps in the rings. Some of the gaps have been cleared out by moons that are within the rings. Other gaps in the rings are caused by the competing gravitational forces of Saturn and of moons outside the rings.

Over **60 moons** have been identified around Saturn. Most of them are very small. Some are even found within the rings. In a sense, all the particles in the rings are like little moons, too, because they orbit around Saturn. Only seven of Saturn's moons are large enough for gravity to have made them spherical, and all but one are smaller than Earth's moon.

Saturn orbits the Sun once about every **30 Earth years.**

Saturn is on average **920.2 million miles** from the Sun.

Saturn’s **day is 10 hrs and 42 minutes.**

CHECK: how many Astronomical Units is Saturn from the Sun? _________

Uranus is named for the Greek god of the sky. In Greek mythology, Uranus was the father of Cronos, the Greek equivalent of the Roman god Saturn.

Uranus was **not known to ancient observers**. It was first discovered by the astronomer **William Herschel** in 1781, who discovered it with a **telescope.**

Like Jupiter and Saturn, **Uranus is composed mainly of hydrogen and helium.** It has a thick layer of gas on the outside, then liquid further on the inside. However, Uranus has a higher percentage of icy materials, such as water, ammonia (NH3), and methane (CH4), than Jupiter and Saturn do. When sunlight reflects off Uranus, clouds of methane filter out red light, giving the **planet a blue-green color**. There are bands of clouds in the atmosphere of Uranus, but they are hard to see in normal light, so the planet looks like a plain blue ball.

Uranus is the **smallest of the outer planets**, with a mass about 14 times the mass of Earth. Even though it has much more mass than Earth, it is much less dense than Earth. At the "surface" of Uranus, the gravity is actually weaker than on Earth's surface. If you were at the top of the clouds on Uranus, you would weigh about 10% less than what you weigh on Earth.

Most of the planets in the solar system rotate on their axes in the same direction that they move around the Sun. **Uranus, though, is tilted on its side so its axis is almost parallel to its**

orbit. In other words, it rotates like a top that was turned so that it was spinning parallel to the floor. Scientists think that Uranus was probably knocked over by a collision with another planet-sized object billions of years ago.

Uranus has **27 moons** that we know of. All but a few of them are named for characters from the plays of William Shakespeare

Uranus is, on average, **1.8 billion miles** from the Sun.

Uranus orbits the Sun every **84 Earth Years**.

Uranus' **day** is just over 17 hours long.

CHECK: how many Astronomical Units is Uranus from the Sun? _________

Neptune is the **eighth and furthest planet** from the Sun. It cannot be seen from Earth without a telescope. Scientists **predicted the existence of Neptune** before it was actually discovered. They noticed that Uranus did not always appear exactly where it should appear. They knew there must be another planet beyond Uranus whose gravity was affecting Uranus' orbit. This planet was discovered in 1846**, in the position that had been predicted**, and it was named Neptune for the Roman god of the sea due to its **blue-ish color**.

Neptune has slightly more mass than Uranus, but it is slightly smaller in diamter. In many respects, it is similar to Uranus. **Uranus and Neptune are often considered "sister planets."**

Neptune is blue in color, with a few darker and lighter spots. The blue color is caused by atmospheric gases, including methane (CH_4). The **winds on Neptune are stronger than on any other planet in the solar system**, reaching speeds of 1,100 km/h (700 mi/h), close to the speed of sound. This extreme weather surprised astronomers, since the planet receives little energy from the Sun to power weather systems. Neptune is also **one of the coldest places in the solar system**. Temperatures at the top of the clouds are about –218°C (–360°F).

Like the other outer planets, Neptune has rings of ice and dust. These rings are much thinner and fainter than those of Saturn. Some evidence suggests that the rings of Neptune may be unstable, and may change or disappear in a relatively short time.

Neptune has 13 known moons.

Neptune is on average **2.8 billion miles from the Sun**.

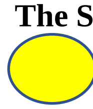
It moves very slowly in its orbit, taking **165 Earth years to complete one orbit around the Sun.**

Neptune's day is just over 16 hours long.

CHECK: how many Astronomical Units is Neptune from the Sun? _________

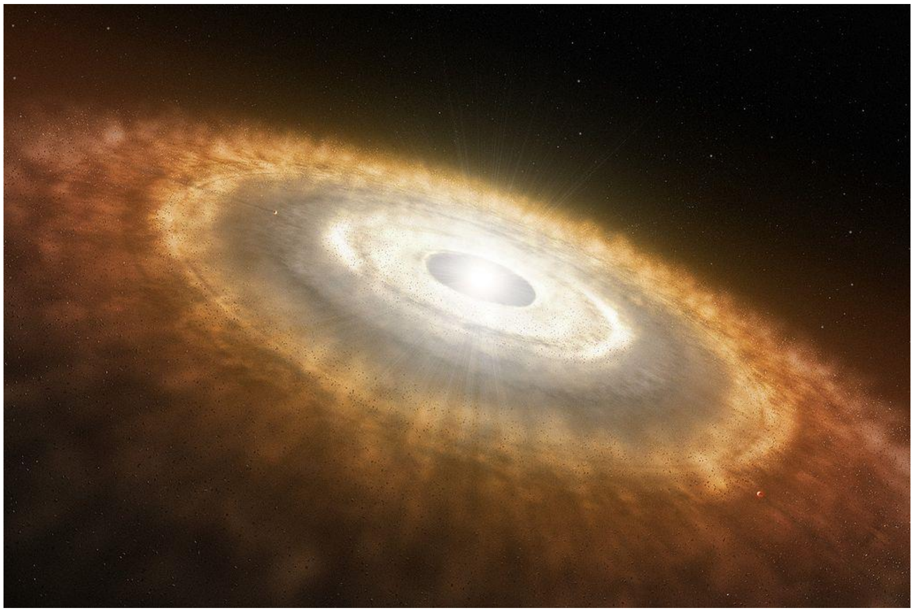
In the space below, draw and label a scale model of the **outer solar system**. The distance from the Earth to the sun, 93 million miles or 1 Astronomical Unit, is equal to 0.25 inches. Next to each planet write 2 distinct facts about it.

The Sun



Wednesday, March 24

Lesson 2: The formation of the Solar System and the Earth/Moon system.

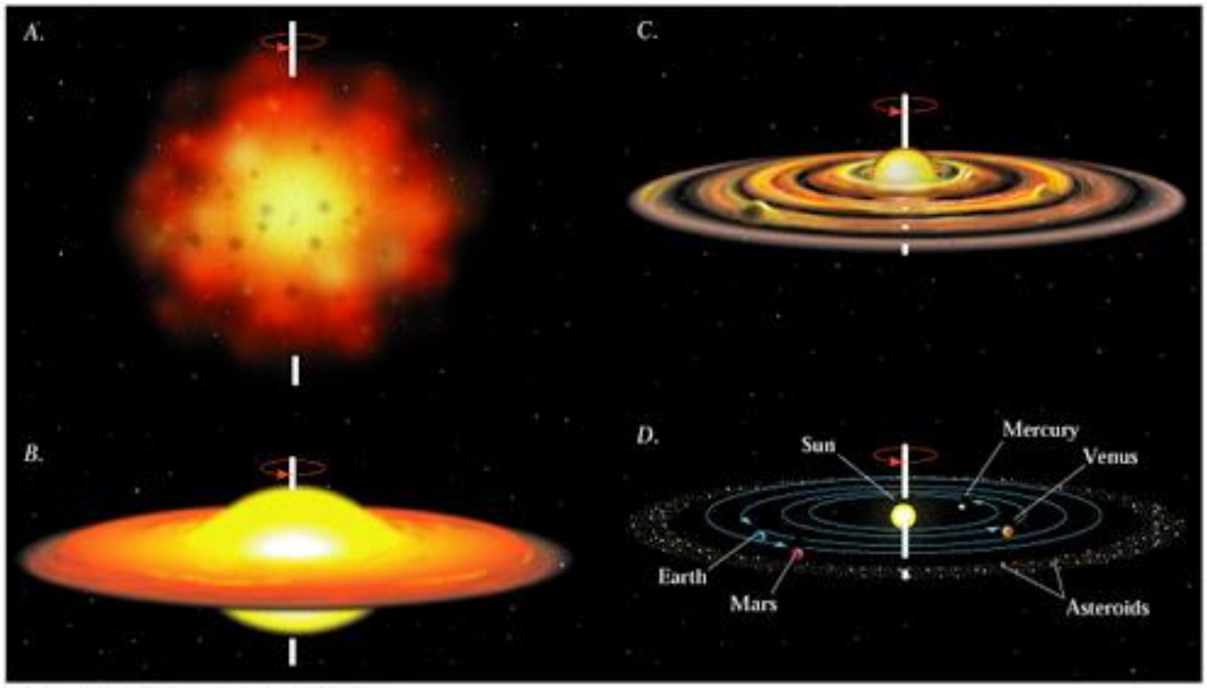


An artist's impression of the 'protoplanetary disk.'

There are two key features of the solar system we haven't mentioned yet. First, **all the planets lie in nearly the same plane**, or flat disk like region. Second**, all the planets orbit in the same direction around the Sun**. These two features are clues to how the solar system formed.

The most widely accepted explanation of how the solar system formed is called the **nebular hypothesis**. According to this hypothesis, the solar system formed **about 4.6 billion years ago** from the collapse of **a giant cloud of gas and dust, called a nebula** (A. in the image below) The nebula was made mostly of hydrogen and helium, but there were heavier elements as well.

The **nebula was drawn together by its own gravity**. As the nebula collapsed, it started to spin (B in the image below). As it collapsed further, the spinning got faster, much as an ice skater spins faster when he pulls his arms to his sides during a spin move. This effect, called "conservation of angular momentum", along with complex effects of gravity, pressure, and radiation, caused the nebula to form into a disk shape (C in the image below). This disk is known as the **protoplanetary disk.** This is why all the planets are found in the same plane (D in the image below).



As gravity pulled matter into the center of the disk, the density and pressure increased at the center. **When the pressure in the center was high enough that nuclear fusion reactions started in the center, a star was born—the Sun** (we'll explore stellar formation in more depth next week).

Meanwhile, the outer parts of the disk were cooling off. Small pieces of dust in the disk started clumping together. These clumps collided and combined with other clumps. Larger clumps, called ***planetesimals***, attracted smaller clumps with their gravity. **Eventually, the planetesimals formed the planets and moons that we find in our solar system today.**

The outer planets—Jupiter, Saturn, Uranus and Neptune—**condensed farther from the Sun from lighter materials such as hydrogen, helium, water, ammonia, and methane**. Out by Jupiter and beyond, where it's very cold, these materials can form solid particles. But in closer to the Sun, these same materials are gases. As a result**, the inner planets—Mercury, Venus, Earth, and Mars—formed from dense rock, which is solid even when close to the Sun.**

The Earth's **Moon** is believed to have formed in the later stages of this process, through a process known as **the giant-impact hypothesis**.

The **giant-impact hypothesis** suggests that the moon formed from the debris of a collision between the **proto-Earth and a Mars-sized planetesimal**, approximately **4.5 billion years ago,** or about 20 to 100 million years after the Solar System coalesced. The colliding body is sometimes called Theia, from the name of the mythical Greek Titan who was the mother of Selene, the goddess of the Moon.

Supporting evidence for this theory includes:

1. Moon samples indicate that the Moon's surface was once molten.
2. The Moon has a relatively small iron core.
3. The Moon has a lower density than Earth.
4. There is evidence in other star systems of similar collisions, resulting in debris discs.
5. Giant collisions are consistent with the nebular hypothesis of the solar system.

Questions:

1. The planets in our solar system are thought to have come from

a. clumps of rocky material that exist between the stars
b. the same cloud of gas and dust in which the Sun formed
c. a cloud of gas in the Orion nebula
d. the Sun (they were flung out of the fast-spinning young sun)

2. As the solar nebula collapsed, it became a disk because

a. the overall rotation of the nebula plus collisions between particles made the particles go in more or less the same direction
b. the initial cloud was disk shaped
c. the Sun's gravity pulled the nebula material into the ecliptic plane
d. the self-gravity of the nebula pulled the material into the ecliptic plane

3. The outer planets are mostly large and gaseous because

a. beyond a certain distance from the sun, hydrogen froze to form the outer planets
b. the Sun's gravity caused the denser rock and metals to settle towards the center of the solar system, leaving lighter materials in the outer system
c. beyond the frost line, the gravity of large, ice-rich planetesimals captured the abundant light gases
d. the disk's spin flung lighter materials farther from the Sun

4. Because of the temperatures in the protoplanetary disk,

a. rocks, metals, and ices (hydrogen compounds) froze in the inner region only
b. rocks and metals froze in both the inner and outer regions, and ices froze only in the outer region
c. rocks and metals froze in the inner region only, and ices froze in the outer region only
d. rocks and metals froze in both the inner and outer regions, and ices and H and He gases froze only in the outer region

5. As the solar nebula collapsed under its own gravity,

a. it heated and spun up b. it cooled and spun up

c. it cooled and spun down d. it heated and spun down

6. You are sent to find dense and rocky planets. Where in the Solar System should you look?

a. very far from the sun b. only in the middle

c. close to the sun d. in circular orbits

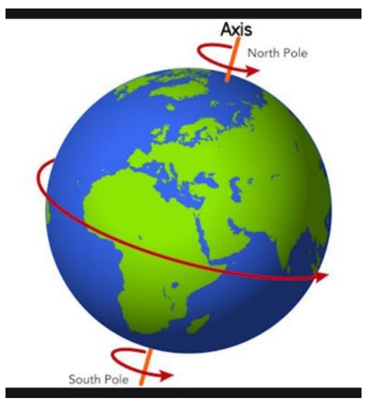
e. in regions with lots of moons

<u>Thursday, March 26</u>
Lesson 4: The day/night cycle, the seasons, and the lunar phases.

Objective: You will be able to explain the cycles of Day and Night; the 4 seasons on Earth; and the Lunar Cycle.

Socratic Guiding Question: Keep these questions in mind as you study this lesson! What change is occurring? What is causing the change? What is the result of this change?

As inhabitants of our planet, Earth, we observe and experience many changes that are in flux, a constant state of change. Yesterday, Wednesday, you learned the shape and movement of our solar system. The sun is at the center of our solar system and our earth is orbiting in an elliptical(an oval or elongated circle) pattern around the sun. As Earth travels in this orbit around the sun, it rotates counter clockwise. Stand up, stretch out your arms, look to your left hand, and slowly turn your body around to the left. This is the direction of how Earth rotates, slowly spinning on an axis, an imaginary line that runs from the North Pole vertically down the planet to the South Pole, as it orbits the sun.



The earth takes 24 hours to make a complete rotation on its axis. With this knowledge, you can stand outside your house in the morning, approximately 7:30 am, you will see the sun appear on the horizon in the east. If you continue to stand all day, you will see the sun seems to travel across the sky, but what is actually occuring is *you* are slowly turning and therefore traveling through the sun's shining light. As you stand in the same location outside of your home, you will see the sun's light continue to shine across the sky and eventually seem to descend in the West, and finally observe the sun set approximately 7:30 pm on the western horizon.

As you observe the sunlight shining, this is called Day. As the earth continues to rotate on its axis, the sun's light is shining around the other side of our planet, and therefore our side is then dark. Without the sun's light it is called Night.

ACTIVITY:

1. Go outside of your house with a piece of paper and pencil. Draw a picture where the sun is shining in the sky in relation to where you are standing, and write down the time of day.
2. With your parents, you can observe this simulated NASA video, to view how the sun's light shines on the earth as it rotates on its axis. The area where the sunlight is shining onto our planet is Day and the area that is dark, without sunlight, is Night. https://youtu.be/laiVuCmEjlg
3. Using a light source, such as a flashlight, or lamp; then curl your fingers into your hand to make a fist. Turn on your small light source, the flashlight or lamp, turn all other light sources off so the only light shining is from your flashlight or lamp. Place your fist 6-12 inches away from the light source, the flashlight or lamp. The side of your fist that the light is shining on represents Day and the other side of your fist that is dark, without light shining on it, represents Night. Unfold your fist, turn back on your room's main light source, and then turn off your small lightsource, the flashlight or lamp, being careful not to touch their lightbulb as they may be extremely warm.

Response:

What change is occurring? Hint: we see a change during 2 different 12 hour periods.

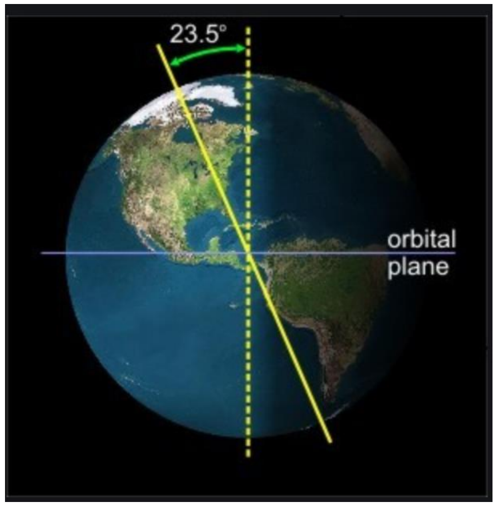
What is causing the change of Day and Night?

What is the result of this change of Day and Night?

Change of Seasons:

With this knowledge of how the sun's light shines on the earth as it rotates on its axis, we can further understand the change of seasons on our planet.

We know the sun is the center of our solar system and that our planet, Earth, rotates around the sun, simultaneously, at the same time, rotating on its axis. This axis is an imaginary line beginning from the North Pole running vertically, up and down, to the South Pole. This axis is not perpendicular to its orbital plane to the sun. The earth's axis is presently tilted approximately 23.5 degrees from the plane of its orbit of the sun. As shown in the illustration below.

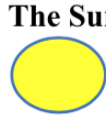


As the earth rotates on its tilted axis around the sun, there will be a continuous change of climate, weather and temperatures. These are times of year that Earth experiences a change of season, or times of year that are governed by annual equinoxes. The Equinox occurs twice a year when the plane of the Earth's equator passes through the center of the sun, around September 22 and March 20.

When Earth's orbit has the planet tilt with the Northern Hemisphere, the top half, north of the Equator, the imaginary line running horizontally around the circumference of Earth, is tilted closer towards the sun. Therefore, the Northern Hemisphere will have a warmer climate, which we refer to as the season of summer. Contrary to the Northern Hemisphere is the Southern Hemisphere, south of the Equator, which would then be tilted away, causing the climate to be cooler, for a season we call Winter. The transition seasons have inclimate weather slowly evolving into the next season. The season from the warmest season, Summer, progressing to the coldest, Winter, is the season of Autumn. The season from the coldest season, Winter, progressing to the warmest season, Summer, is the season of Spring.

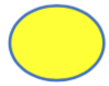
Draw the earth with the Northern Hemisphere during the season of Winter.

The Sun



Draw the earth with the Northern Hemisphere during the season of Summer.

The Sun

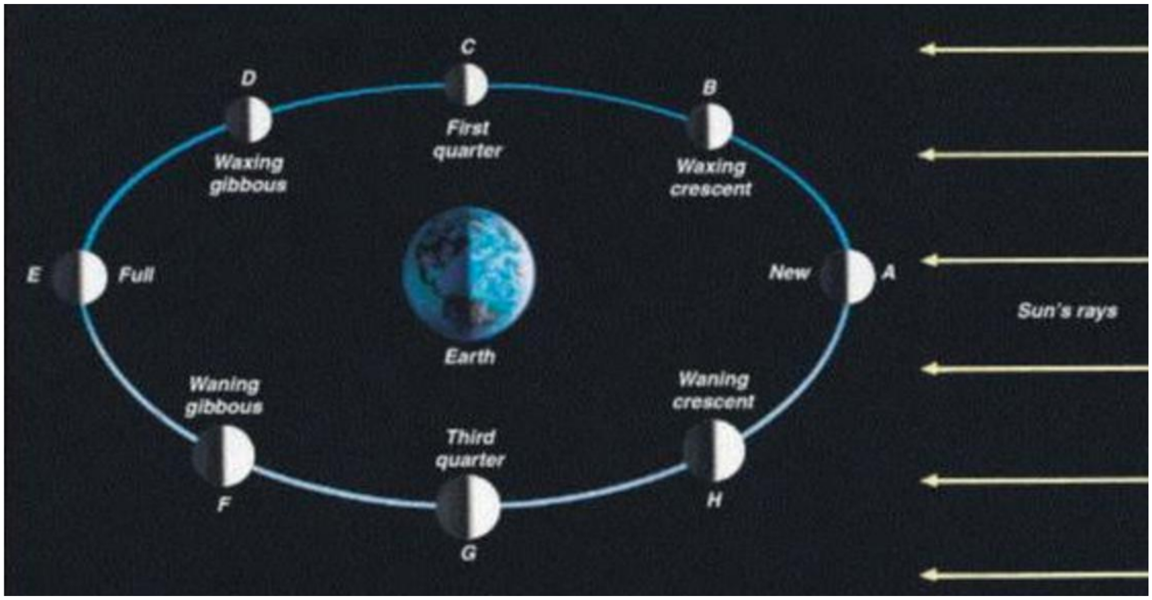


Response:
What change is occurring 4 different times in a year to the earth's climate, weather and temperature? And what are the 4 names of these changes?

What is causing the change of seasons?

What is the result of this change of seasons?

Changes in the Moon:
We see the moon in various phases in the night sky. This is referred to as the Lunar Cycle. The earth's moon rotates on an orbit around Earth. This orbit takes approximately 29 days. As the moon travels on its path around the earth, the sun's light will cast light on it, the earth will cast shadow on it, depending where the moon is located in its orbital path.
The sun is the center of our solar system. The earth rotates around the sun and the moon rotates around the earth. As the moon travels on its orbit around the earth it will be in a different position and therefore the sun's light will shine on it from a different angle or the earth will cast a shadow on the moon. This light and shadow will give the moon a different appearance from our perspective on Earth, depending where the moon is located in its orbit. When the moon is on its orbit placed between the sun and the earth, the sun is shining directly behind the moon and the earth is facing the sun, so the earth is facing the shadowed or dark side of the moon. We refer to this as the New Moon. We then begin counting and tracking the moons cycle for the next 29 days. As it travels, we see the moon in its various stages of the cycle.
View the illustration below to observe the light on the moon. There are 8 phases of the moon during its Lunar Cycle.



Draw what the moon will look like at each stage for the **Lunar Cycle**:

A. New Moon:

B. Waxing Crescent:

C. 1st Quarter:

D. Waxing Gibbous:

E. Full Moon:

F. Waning Gibbous:

G. 3rd Quarter:

H. Waning Crescent:

Response:
What change is occurring to the moon?

How many phases of the moon are there and name them?

What is causing the change in how we see the moon?

What is the result of this change?

Friday, March 27
Lesson 5: Ocean tides and their relation to the lunar cycle.

Objective: You will be able to explain how tides work in relation to the lunar cycle.

Socratic Guiding Question: What is causing the ocean waters to rise and fall along the coasts? What is the force that is causing this effect? How does the moon affect the tides?

The oceans cover over 70% of Earth's surface. As shown in the image above, the shorelines of the oceans seem to rise and fall. This reliable phenomena is referred to as Tides. We have observed there is a correlation of the lunar cycle (the moon orbiting Earth) and the ocean tides.

Gravity, a force that attracts a body toward the center of the earth, or toward any other physical body having mass, has an affect on the celestial objects: Sun, Earth and Moon. The ocean's tides are a response to this gravitational pull during the lunar cycle.

In 1616 Galileo wrote Discourse on the Tides to use the tides of the ocean to explain his theory that the Earth orbits the Sun.

Then, in 1666 Sir Isaac Newton created the theories of gravitation and then conceived the 3 Laws of Motion in 1686.

1st Law, sometimes referred to as the **law** of inertia. **Newton's** first **law** of motion is often stated as: An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

2nd Law, stated as: that the greater the mass of an object, the more force it will take to accelerate the object. This also means that the harder you kick a ball the farther it will go. The formula shown with the 2nd Law is F=ma (Force equals mass times acceleration)

3rd Law, stated as: a force is a push or a pull that acts upon an object as a result of its interaction with another object. ... These two forces are called action and reaction forces and are the subject of Newton's third **law of motion**. Formally stated, Newton's third **law** is: For every action, there is an equal and opposite reaction.

Gravity is one major force that creates tides. In 1687, Sir Isaac Newton explained that ocean tides result from the gravitational attraction of the sun and moon on the oceans of the earth.

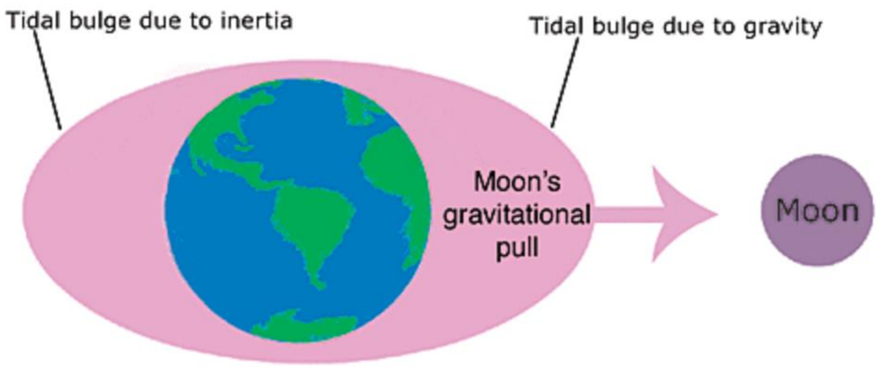
Newton's law of universal gravitation states that the gravitational attraction between two bodies is directly proportional to their masses, and inversely proportional to the square of the distance between the bodies. Therefore, the greater the mass of the objects and the closer they are to each other, the greater the gravitational attraction between them.

Tidal forces are based on the gravitational attractive force. With regard to tidal forces on the Earth, the distance between two objects usually is more critical than their masses. Tidal generating forces vary inversely as the cube of the distance from the tide generating object. Gravitational attractive forces only vary inversely to the square of the distance between the objects. The effect of distance on tidal forces is seen in the relationship between the sun, the moon, and the Earth's waters.

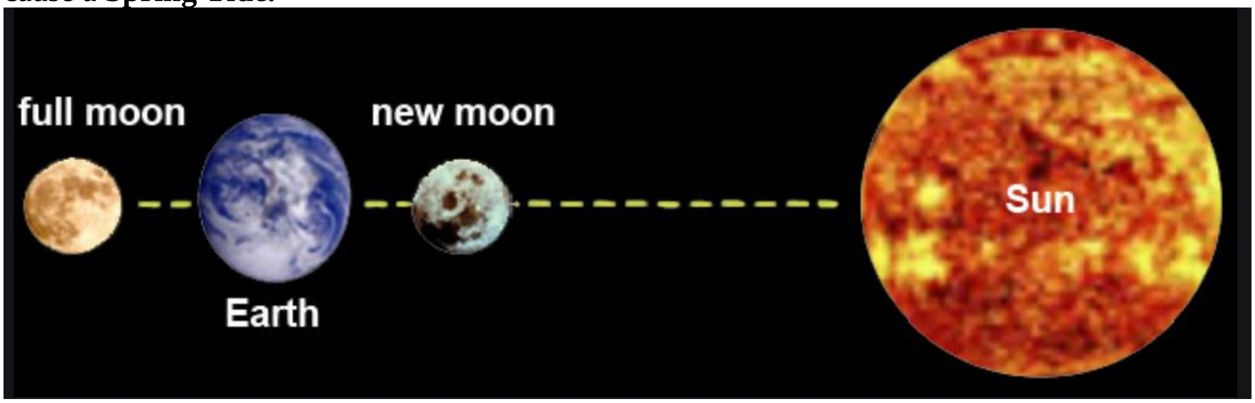
But it was Newton's Equilibrium Theory that explains that gravitation consists of 2 symmetric tidal bulges, directly under and directly opposite the moon or sun.

The gravitational attraction between the Earth and the moon is strongest on the side of the Earth that happens to be facing the moon, simply because it is closer. This attraction causes the water on this "near side" of Earth to be pulled toward the moon. As gravitational force acts to draw the water closer to the moon, inertia attempts to keep the water in place. But the gravitational force exceeds it and the water is pulled toward the moon, causing a "bulge" of water on the near side toward the moon. The theory of **inertia**, the tendency of moving objects to continue moving in a straight line or stay motionless, also **affects** the **tidal** bulge. As the gravitational force draws water closer to the Moon the inertial force on the opposite side of the earth tries to keep the ocean on that side in place.

So, on the opposite side of the Earth, or the "far side," the gravitational attraction of the moon is less because it is farther away. Here, inertia exceeds the gravitational force, and the water tries to keep going in a straight line, moving away from the Earth, also forming a bulge.
In this way the combination of gravity and inertia create two bulges of water. One forms where the Earth and moon are closest, and the other forms where they are furthest apart. Over the rest of the globe gravity and inertia are in relative balance. Because water is fluid, the two bulges stay aligned with the moon as the Earth rotates. (Source: U.S. Department of Commerce)



The sun also plays a major role, affecting the size and position of the two tidal bulges. When the sun and moon are both lined up with the earth, there is a stronger gravitational pull, which will cause a **Spring Tide.**

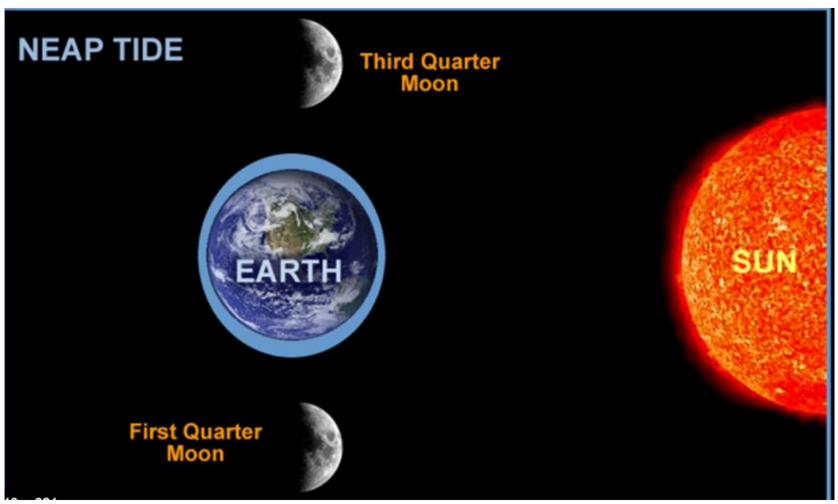


Gravity, a force that attracts a body toward the center of the earth, or toward any other physical body having mass, has an affect on the celestial objects: Sun, Earth and Moon. The ocean's tides are a response to this gravitational pull during the lunar cycle.

Tidal Force is the difference in gravitational forces of Sun, Earth and Moon.

This illustration demonstrates when there is a **High Tide**, when the water is higher on the shoreline during New Moon and Full Moon, also known as **Spring Tide** when there is the ***most*** gravitational pull.

This illustration demonstrates when there is a **Low Tide**, when the water is lower on the shoreline, which occurs during the 1st and 3rd Quarter phases of the moon, also known as **Neap Tide** when there is a moderate or ***lesser*** gravitational pull.



During the Lunar cycle, as the moon travels along its orbit of the earth, the gravitational pull on earth travels around with the effect of tides on the oceans: New Moon, Waxing Crescent, 1st Quarter, Waxing Gibbous, Full Moon, Waning Gibbous, 3rd Quarter, Waning Crescent

Return to Thursday, March 26 in this packet, and to your **Lunar Cycle** drawings: New Moon, Waxing Crescent, 1st Quarter, Waxing Gibbous, Full Moon, Waning Gibbous, 3rd Quarter, Waning Crescent

There are **2 phases** of the moon where there will be a High Tide when the gravitational pull is the strongest, also known as **Spring Tide**. There will also be **2 phases** where there will be a Low Tide when the gravitational pull is less, also known as **Neap Tide**.

Write next to your drawings from March 26 which 2 phases should be labeled Spring Tide and 2 phases should be labeled Neap Tide.

Response:

What is causing the ocean waters to rise and fall along the coasts?

What is the force that is causing this effect?

How does the moon affect the tides?

How does this knowledge of tides benefit humans, other creatures and shorelines?