Astronomy

How is the geocentric theory different from the heliocentric theory?

Terms Part 1

- Universe
- Big Bang
- Galaxies
- Nebula
- Orbits
- Solar System
- Geocentric Theory
- Heliocentric Theory
- Galileo
- Copernicus

How is the geocentric theory different from the heliocentric theory?

- What do most scientists say produced the universe?
- Compare and Contrast the geocentric theory and the heliocentric theory.
- Who was Copernicus and what did he propose that was later supported by observations made by Galileo?

The Formation of Our Solar System

- Most scientists believe that the ***universe*** began about 13.5 billion years ago in a great explosion, called the ***Big Bang***.
- Later, the space material from the explosion formed the first stars.
- These stars were drawn together by gravity to produce family of stars, called ***galaxies***.

A **galaxy** is a large group of stars, gas, and dust held together by gravity



There are three types of galaxies …

Elliptical, Irregular, and Spiral

Can you guess which one is which?

Spiral Galaxy – a central bulge of older stars and arms that stretch outward like a wheel

Elliptical Galaxy – has an oval shape with a bright center.

Irregular Galaxy – Galaxies that are not spiral or elliptical are considered **irregular**

The Formation of Our Solar System

- Most scientists believe that about 5 billion years ago, a gigantic cloud of gases and dust, called a ***nebula***, was disturbed and began to spin.
- Something disturbed the nebula causing it to spin
- As it spun, material clumped together. Intense heat and pressure created **our sun**
- Grains of dust surrounding the sun collided over and over to form planets, moons, and comets in **our solar system**

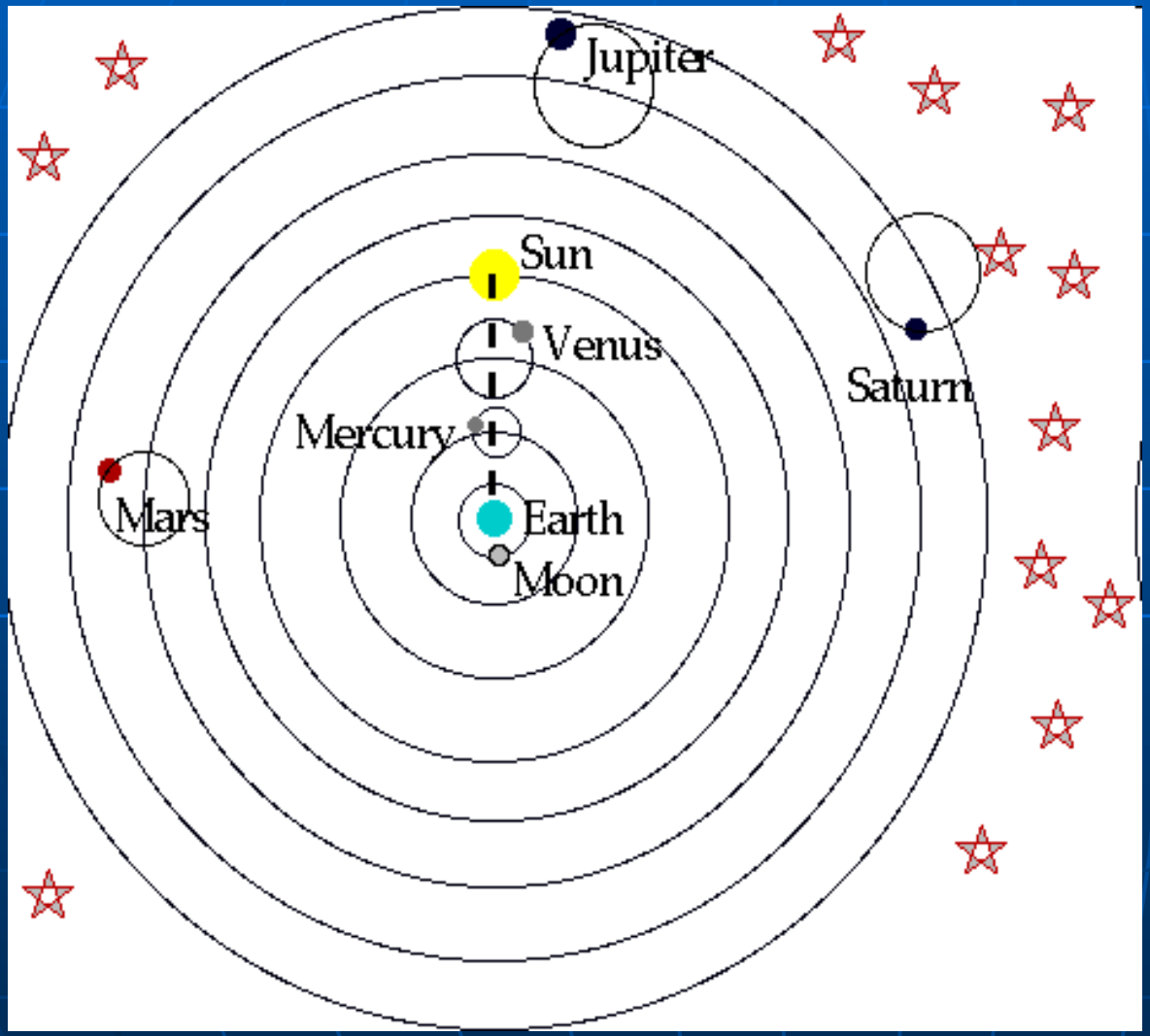
The Formation of Our Solar System,

- These objects revolve around the sun in paths called ***orbits***.
- Centuries ago, most people thought Earth was the center of the solar system, not the sun. This theory is called the ***geocentric theory***.
- The idea that the sun is the center of the solar system is called the ***heliocentric theory***.
- ***Copernicus*** was an astronomer. He suggested that the sun, not Earth, was the center of the solar system.

Geocentric Theory

- What does the prefix geo- mean?
- What does –centric mean?
- What do you think geocentric means?

Geocentric Theory



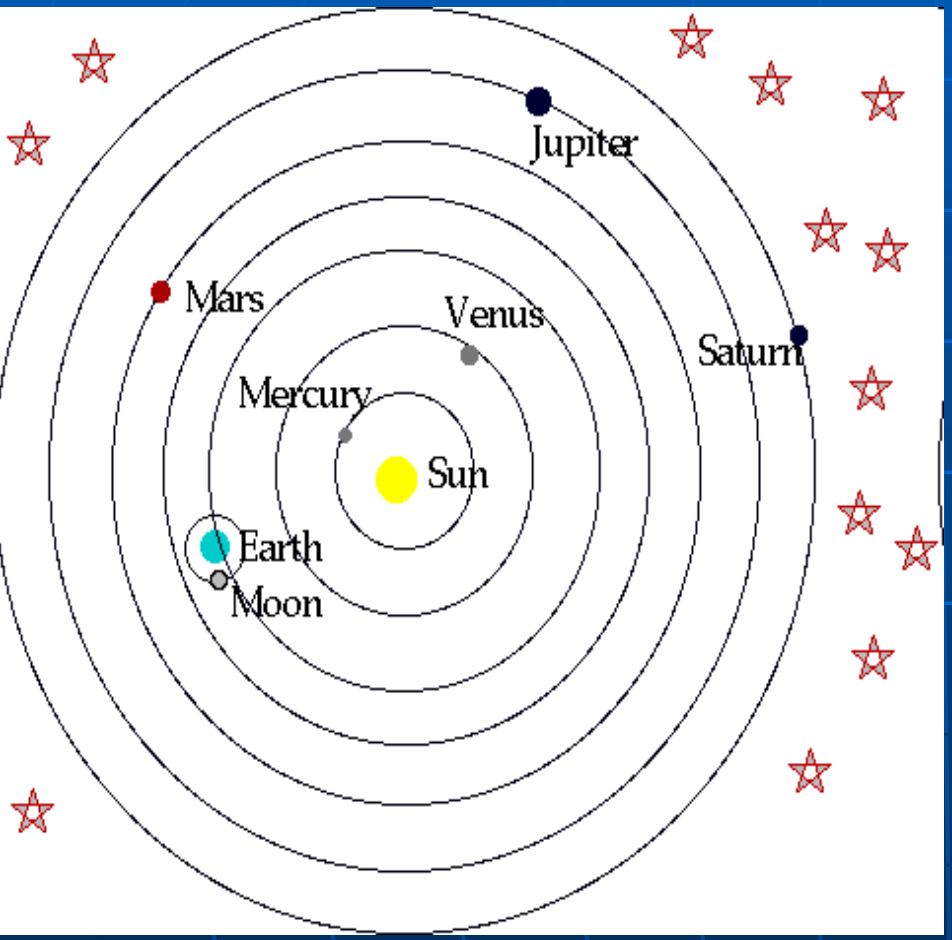
- **Geocentric** means earth centered.
- Ptolemy developed the geocentric theory
- A long time ago people thought Earth was the center of our solar system and everything revolved around it

Heliocentric Theory

What does the prefix helio- mean?

What do you think heliocentric means?

Heliocentric Theory



- **Heliocentric** means sun centered
- Copernicus was the first person to suggest that the sun was the center of the solar system
- Galileo used telescopes to make observations that the sun was the center of the solar system

The Formation of Our Solar System,

- ***Galileo*** invented a telescope and discovered 4 moons revolving Jupiter.
- He concluded that not everything in the solar system revolved around Earth.
- Galileo found that Venus goes through phases like those of the moon, as predicted by Copernicus.
- Galileo reasoned that this could happen only if Venus revolved around the sun, not around Earth.

Quick Check

What did the geocentric theory state?

A. The sun is at the center of the solar system.
B. Earth is at the center of the solar system.
C. The universe began with a great explosion.
D. The earth revolves around a moon.

Quick Check

What object is the largest?

A. Earth

B. the sun

C. the Milky Way Galaxy

D. a star

Quick Check

Which happened MOST recently?

A. the formation of the universe

B. the formation of the solar system

C. the formation of the sun

D. the formation of the Milky Way Galaxy

Quick Check

The solar system is thought to be formed from which of the following objects?

A. the sun

B. the Milky Way Galaxy

C. a nebula

D. the universe

Quick Check

What was the FIRST discovery made by Galileo that supported Copernicus' idea that the sun, not the earth, was at the center of the solar system?

A. the discovery of Jupiter

B. the discovery of some of Jupiter's moons

C. The discovery of the phases of Venus

D. the discovery of the telescope

Quick Check

What hypothesis was proposed by Nicolas Copernicus that was later supported by observations made by Galileo?

a. The universe began with a Big Bang.

b. Earth is the center of the solar system.

c. The sun is the center of the solar system.

d. The solar system is about 4.5 billion years old.

Quick Check

From the oldest event to the most recent event in the formation of the solar system, which is the correct sequence?

a. nebula, Big Bang, sun

b. Big Bang, nebula, sun

c. sun, nebula, Big Bang

d. Big Bang, sun, nebula

Quick Check

To what hypothesis does the Big Bang refer?

a. an explanation of how the universe began

b. an explanation of how the Milky Way Galaxy began

c. an explanation of how the solar system began

d. an explanation of how Earth began

The Position of the Solar System

Terms

- Light year = 1 light year is the distance light travels in a year.
- 1 light year = 9.5 trillion km

- Astronomical unit = 1 astronomical unit is the average distance between the sun and Earth (150,000,000 km).

What is the position or location of our solar system?

- What is a light year?
- Give a detailed description of the Milky Way Galaxy.
- Where is our solar system located?
- What is an astronomical unit?

778,000,000

What do you think this number means?

money?

# of People?

Baseball players salary?

Number of hairs on your head?

778,000,000
kilometers
is the distance
from the
sun to Jupiter!

1 meter = 150,000,000km

EX: $\frac{378{,}000{,}000 \text{ km}}{150{,}000{,}000} = 2.8$

You need 2.8 meters

Measuring Space

A **light year** is the distance light travels in 1 year → it is approximately 9.5 trillion kilometers

An **Astronomical Unit (AU)** is the average distance between Earth and the sun → one AU is approximately 150,000,000 kilometers

The Position of the Solar System

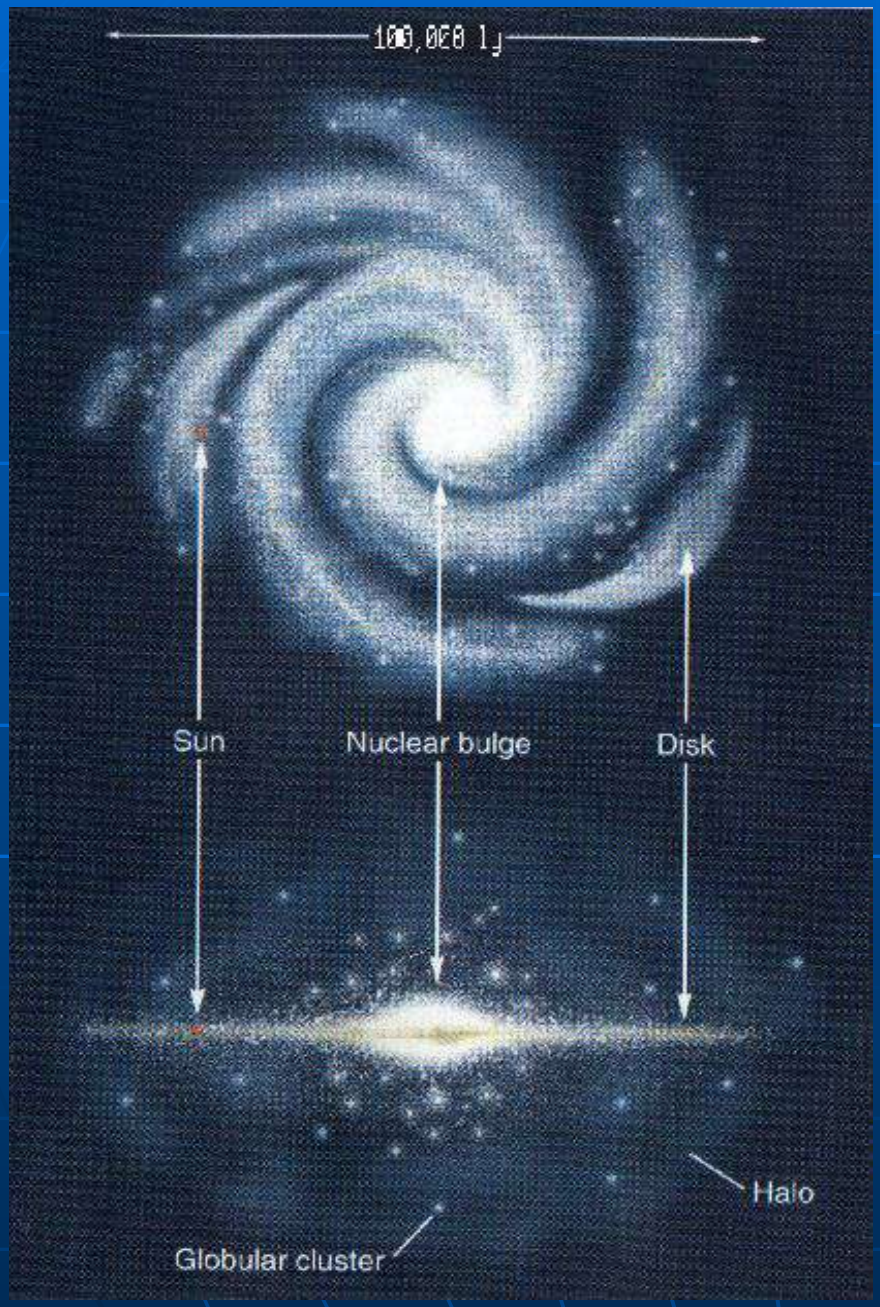
- A light year is the distance light travels in a year. The most distant objects observed from Earth are about 13.6 billion light years away. One (1) light year = 9.5 trillion km.
- Galaxies come in all sizes and shapes. The Milky Way Galaxy is shaped like a giant flattened disc with a bulge in the middle.
- Spiral arms spin out into space from the Milky Way Galaxy's center.

The Position of the Solar System

- The Milky Way is about 100,000 light years (9.5 million trillion km) in diameter.
- It is between 1000 to 3000 light years (9.3 million billion km to 31.0 million billion km) thick.
- It is thickest at the center.

The Position of the Solar System

- Our solar system is located in one of the galaxy's outer arms.
- The sun is about 30,000 light years away from the center of the galaxy.
- It takes our solar system about 240 million years to circle the center of the galaxy.
- An astronomical unit is the average distance between Earth and the sun. An astronomical unit is about 150,000,000 km



We live in a spiral galaxy called the Milky Way Galaxy

Our solar system lies on one of the outer arms called Orions Arm

Quick Check

Where in the Milky Way Galaxy is the solar system found?

A. In its center

B. In an inner arm

C. In an outer arm

D. Outside the Milky Way's out edge

Quick Check

A light year is a unit of

A. time.
B. volume.
C. speed.
D. distance.

Quick Check

If a space probe were able to move at half the speed of light, how long would it take the probe to travel from Earth to the center of the Milky Way Galaxy?

A. 15,000 light years

B. 30,000 light years

C. 60,000 light years

D. 120,000 light years

Quick Check

Light travels about 300,000 km a second. The sun is about 150,000,000 km from Earth. About how long does light take to travel from the sun to Earth?

- A. 8 seconds
- B. 8 minutes
- C. 8 hours
- D. 8 years

Quick Check

The nearest star outside our solar system is about 4.2 light years away. About what distance would this be in kilometers?

A. 40 trillion

B. 400 trillion

C. 4000 trillion

D. 4 trillion

The Planets
Terms

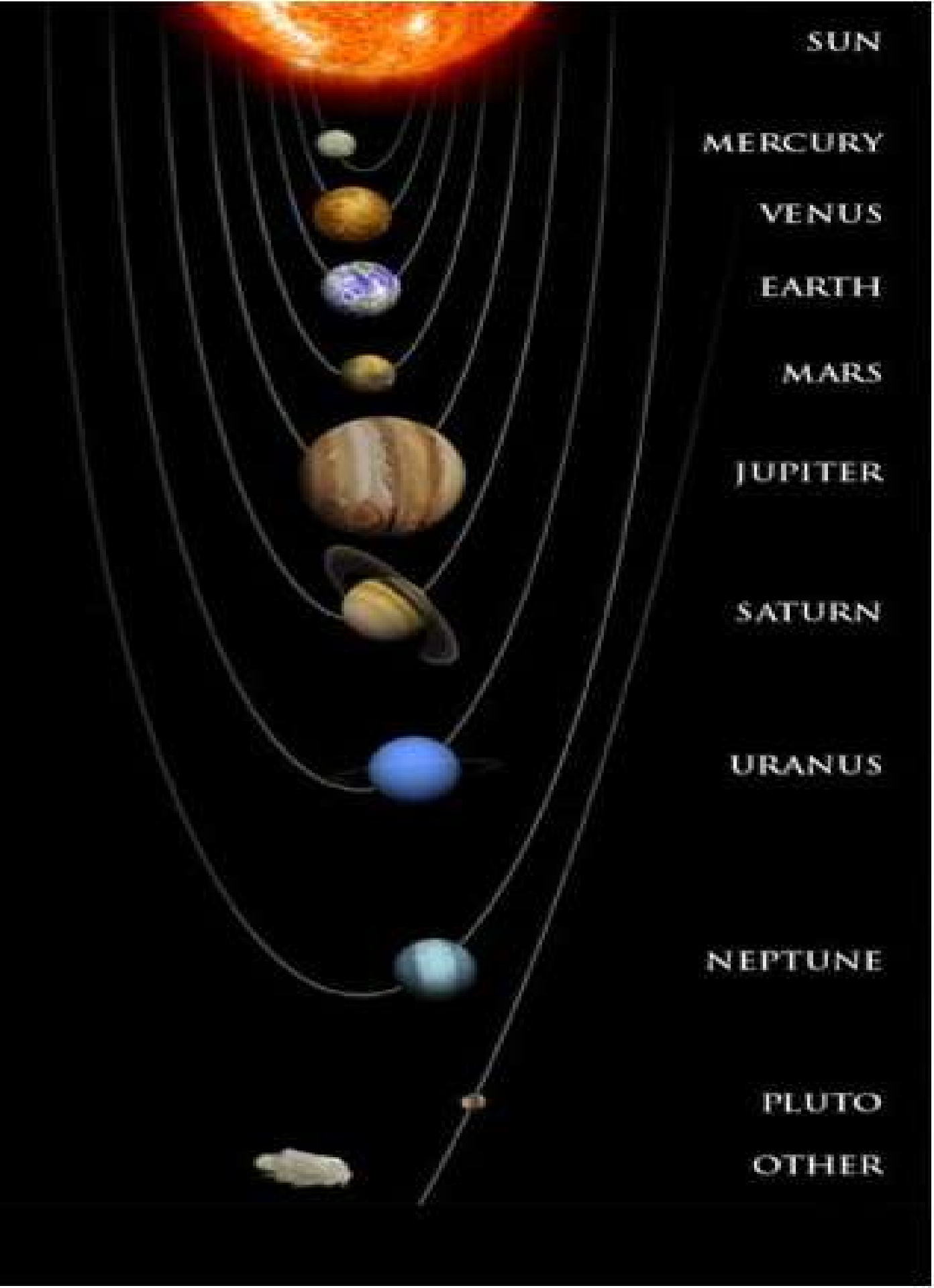
- Mercury
- Venus
- Earth
- Mars
- Jupiter
- Saturn
- Uranus
- Neptune
- Pluto (Dwarf Planet)

How are the planets alike and/or different?

- What factors exists on Earth that make life possible here, but unlikely on any other planet?
- Which planets in the solar system are called the “gas giants” and why?
- In general, what condition on the planets is MOST affected by its distance from the sun?

The Planets

- Earth's atmosphere is about 78% nitrogen, 21% oxygen.
- Liquid water, moderate temperature, and an atmosphere rich in oxygen make Earth the only planet that can support life as we know it.
- The planets, Jupiter, Saturn, Uranus, and Neptune, are called the "gas giants." This is because they are so much larger than Earth and they do not have well defined surfaces.
- The condition on the planets that is most affected by its distance from the sun is the temperature. The farther away they are from the sun, the lower the temperature on the planet.


SUN
MERCURY
VENUS
EARTH
MARS
JUPITER
SATURN
URANUS
NEPTUNE
PLUTO
OTHER

The Inner Planets

- ***Mercury*** = closest planet to the sun, only Pluto is smaller, rocky surface with many craters, very thin atmosphere, high temperature, no life;
- ***Venus*** = 2nd planet from sun, same size as Earth, rocky surface, atmosphere is very thick with carbon dioxide, gas traps heat under it, no life;
- ***Earth*** =3rd planet from sun, surface is rocky, covered with plains, valleys, mountains, plateaus, active volcanoes, ¾ surface covered with water, atmosphere 78% nitrogen, 21% oxygen, water, moderate temperature, and oxygen makes Earth only planet supporting life;

The Inner Planets

- ***Mars*** = 4th planet from the sun, called "red planet", half the size of Earth, rocky and dusty surface, hills, plains, mountains, extinct volcanoes, craters, largest volcano in solar system, ice caps north and south poles, may have had water at one time, thin atmosphere with carbon dioxide, life may have existed at one time;

The Outer Planets
“Gas Giants”

- **Jupiter** = 5th planet from sun, largest planet, “gas giants," no solid surface, slushy ball of liquid hydrogen, atmosphere mostly helium and hydrogen gases, large red spot (gigantic storm or hurricane), circled by very thin rings, no life;
- **Saturn** = 6th planet from sun, complex ring system, second largest planet, structure similar to Jupiter, atmosphere is hydrogen and helium gases, no life;
- **Uranus** = blue-green color from poisonous methane, 7th planet from sun, third largest planet, surface completely covered with water, methane, and ammonia, 11 rings circle planet, rotates on its side, poles point toward and away from sun, extremely cold temperature, no life;

The Outer Planets
"Gas Giants"

- **Neptune** = 8th planet from the sun, fourth largest planet, glows blue-green with methane gas clouds, icy ocean of water, methane, ammonia, and hydrogen, six rings orbit planet, no life on planet;
- **Pluto** = dwarf planet (?), smallest planet, smaller than Earth's moon, may have rocky surface, surface buried under layer of methane ice, thin atmosphere of methane, nitrogen, and carbon monoxide, too harsh to support life;
- Is Pluto a planet? How does it compare and contrast with inner, outer planets?

Quick Check

What three factors exist on Earth that make life possible here, but unlikely on any other planet?

A. liquid water, moderate temperatures, atmospheric oxygen

B. liquid water, moderate temperatures, atmospheric nitrogen

C. liquid waters, moderate size of Earth, atmospheric oxygen

D. solid water, moderate temperatures, atmospheric oxygen

Quick Check

Which planets in the solar system are called the "gas giants"?

A. Mercury, Venus, Earth, Mars

B. Saturn, Uranus, Neptune, Pluto

C. Jupiter, Saturn, Uranus, Neptune

D. Earth, Venus, Pluto, Mars

Quick Check

Which planet is MOST LIKELY to support life as we know it?

A. Mercury

B. Venus

C. Jupiter

D. Mars

Quick Check

In general, what condition is MOST affected by its distance from the sun?

A. size

B. temperature

C. atmosphere

D. surface composition

Quick Check

The force of gravity on a planet determines the weight of objects on the planet. If you weighted 30 kg (66 pounds) on Earth, what would you weigh on Jupiter?

A. 11.4 kg (5.2 pounds)

B. 30 kg (66 pounds)

C. 34.2 kg (75.4 pounds)

D. 75.9 kg (167.3 pounds)

Quick Check

Planet	Average Distance from the Sun (x millions km)	Diameter (x 1000 km)	Year Length (on Earth days/years)	Gravity (x Earth's)	Moons
Unknown	778	143.0	11.9 y	2.53	63

A. EarthB. Mars

C. JupiterD. Pluto

Quick Check

From nearest to farthest from the sun, which sequence is correct?

A. Mercury, Venus, Earth
B. Mercury, Earth, Venus
C. Venus, Mercury, Earth
D. Venus, Earth, Mercury

Quick Check

Which of the following planets have a rocky surface?

A. Jupiter
B. Uranus
C. Neptune
D. Mercury

Quick Check

In order from smallest to largest, which set of planets is correctly shown?

A. Mars, Earth, Saturn
B. Earth, Mars, Saturn
C. Saturn, Earth, Mars
D. Saturn, Mars, Earth

Quick Check

Mercury has a rocky surface and a very. Very thin atmosphere. There is no liquid water on the planet, Daytime temperatures rise to about 430°C (806°F). Based on these data, what is the MOST reasonable conclusion you can reach about Mercury?

A. It is the farthest planet from the sun.

B. It can support life.

C. It cannot surprise life

It is very much like Earth.

Objects' Motion in the Sky Terms

RotationAxis

Day Year

ConstellationRevolution

Why do the sun and moon seem to move each day?

- What causes day and night?
- If Earth's rotation slowed, what do you think would be most affected?
- Compare and contrast rotation and revolution.

Rotation

- Earth's **rotation** on its axis causes day and night.
- **Rotation** means spinning. Earth's spinning on its axis is called its rotation. Earth makes one complete spin about every 24 hours. One complete spin is called a **day**.
- It takes 24 hrs for the Earth to make one complete spin on its axis. If the earth's rotation slowed, a day would be longer.
- Earth spins around its axis from west to east. This makes objects in the sky appear to be moving from east to west.

Revolution

- In addition to rotating on its axis, Earth travels around the sun. The movement of one object around another object is called **revolution**.
- One complete revolution around the sun is called a year. Earth's path as it revolves around the sun is called its **orbit**.
- As it travels around the sun, Earth's orbit is not a circle, it is **elliptical**, like a slightly flattened circle, or oval shape.

Quick Check

What motion makes objects in the sky seem to rise in the east and set in the west each day?

A. revolution of Earth
B. rotation of Earth
C. revolution of the sun
D. rotation of the sun

Quick Check

What does one revolution of Earth equal?

A. an hour
B. a day
C. a month
D. a year

Quick Check

Around what does Earth rotate?

A. its axis
B. the sun
C. the stars
D. constellations

Quick Check

What motion of Earth makes it seem as if the stars and constellations are in different positions at different times of the year?

A. Earth's rotation
B. the rotation of the stars and constellations
C. the revolution of the stars and constellations
D. the revolution of Earth

Quick Check

If Earth's rotation slowed, which of the following would happen?

A. The stars would not seem to change position.

B. The length of a day would increase.

C. The length of a day would decrease.

D. The length of a day would still be about 24 hours.

Quick Check

Assume Earth's **revolution increased** and its **rotation decreased**. Which set of data would go with these changes?

A. length of a year, 340 days; length of a day, 26 hours

B. length of a year, 370 days; length of a day, 28 hours

C. length of a year, 380 days; length of a day, 23 hours

D. length of a year, 330 days; length of a day, 20 hours

Quick Check

If the time it took Earth to **rotate** once on its axis **increased**,

A. a day would be longer.
B. a day would be shorter.
C. a year would be longer.
D. a year would be shorter.

Gravity Terms

- GravityInertia
- OrbitsEllipse

How do the planets remain in their orbits ?

- What two factors keep the planets in their orbits?
- What is gravity?
- What is inertia?
- What two factors does the strength of the pull of gravity depend upon?

Gravity

- All objects, from the atom to the largest family of stars, possess gravity.
- Gravity is a force that attracts all objects towards each other.
- The strength of the pull of gravity between two objects depends on two factors.
- These two factors are the product of the masses of the objects and the distance between them.

Gravity

- As the product of the masses increases, the pull of gravity also increases.
- If the distance between the two objects increases, then the pull of gravity between them decreases.
- All objects in our solar system travel around the sun in paths called orbits.
- Planets orbit around the sun, and moons are in orbit around planets.

Gravity

- Scientist Sir Isaac Newton discovered 3 Laws of Motion.
- His 1st Law of Motion states that an object in motion will tend to stay in motion at the same speed and direction unless acted on by an outside force.
- The tendency of objects to keep doing what they were doing is called inertia.

Gravity

- Inertia tends to lead planets to follow a straight path at a certain speed unless acted on by an outside force. This outside force is the gravity of the sun.
- While the gravity of the sun pulls the planet towards it, the speed and direction (inertia) of the planet pushes it forward.
- When the forces of gravity and inertia are balanced, the planet follows a curved path around the sun.

Quick Check

What force keeps Earth in orbit around the sun?

A. a pull by one object that is in contact with another object.

B. a push by one object that is in contact with another object.

C. mass

D. gravity

Quick Check

What affects the force of gravity between two objects?

A. the product of their masses and the distance between them
B. only the distance between them
C. only the sum of their masses
D. the mass of the larger object

Quick Check

In what direction does an object in space tend to move?

A. in a curved path
B. inward
C. in a straight line
D. backward

Quick Check

How would the force of gravity between Earth and the sun be affected if the mass of Earth were greater than it is?

A. The force of gravity would be unchanged.

B. The force of gravity would be greater.

C. The force of gravity would be less.

D. There would be no force of gravity.

Quick Check

If the force of gravity between Earth and the sun were greater than Earth's inertia, what would happen to Earth?

A. Earth would escape into space.
B. Earth would fall into the sun.
C. Earth would remain in its orbit around the sun.
D. Earth would stop moving.

How would you describe the characteristics of comets, asteroids, and meteoroids?

- What is a comet made of?
- Where are most asteroids found?
- What is the sequence that describes a meteoroid that falls to Earth's surface?

Comets

- A comet is a chunk of material (ice and dust) called a nucleus.
- When a comet gets close enough to the sun, the energy in the sunlight turns the ice into gas, releasing dust.
- The gas and dust form an outer layer to become an atmosphere called a coma.

Comets

- Most comets revolve around the sun in very long, narrow orbits.
- The main parts of a comet are the nucleus, the coma, and the tail.
- As a comet gets closer to the sun, the sun's energy blows parts of the comet away from the nucleus.
- A comet's tail always points away from the sun because it is formed by energy of the sun that blows outward from the sun.

Asteroids

- Asteroids are chunks of rock and metal.
- Most asteroids exist in a belt between the orbits of Mars and Jupiter. It is known as the asteroid belt.
- Some asteroids come near the orbit of Earth.
- 65 million years ago, a large asteroid hit Earth making a large crater.
- Many scientist hypothesize that as a result many species of organisms, including dinosaurs, became extinct.

Meteoroids

- A ***meteoroid*** is made up of chunks of rock or dust. Many come from comets and asteroids.
- When a meteoroid enters Earth's atmosphere, it heats up and produces a streak of light, called a ***meteor***, or a "shooting star."
- Sometimes, a meteoroid does not burn up in Earth's atmosphere and hits Earth's surface. Meteoroids that hit Earth's surface are called ***meteorites.***

Quick Check

When it approaches the sun, which object produces a shimmering tail that lasts at least a few days?

A. a meteoroid
B. an asteroid
C. a comet
D. the moon

Quick Check

- What is a comet's coma?

- A. the stony and icy center of its head
- B. a chunk of iron
- C a stream of gases at its back
- D. the atmosphere around its nucleus

Quick Check

Where are MOST asteroids found?

A. all over the solar system
B. outside the solar system
C. in orbit between Mars and Jupiter
D. near Earth

Quick Check

What is the sequence that describes a space rock that falls to Earth's surface?

A. meteoroid, meteor, meteorite
B. meteorite, meteor, meteoroid
C. meteor, meteoroid, meteorite
D. meteoroid, meteorite, meteor

Quick Check

Meteoroids usually come from

A. debris from other planets
B. the moon
C. beyond the solar system
D. comets or asteroids

The Phases of the Moon Terms

- Phases= one of the different shapes of the moon as seen from Earth
- Waxing = bright part of the moon ***increase*** in size as time passes
- Waning = bright part of the moon ***decreases*** in size as time passes.

How does the moon change phases?

- What causes the phases of the moon?
- What are the 8 names of the phases of the moon?
- Since the moon does not produce light, how can you see it?

The Phases of the Moon

- The changing shapes of the moon we see are called phases. The phase of the moon you see depends on how much of the sunlit side of the moon faces Earth.
- The moon shows all of its phases in a cycle that lasts 29.5 days.
- The names of the moon's 8 phases in order of appearance are: new moon, waxing crescent, first quarter, waxing gibbous, full moon, waning gibbous, 3rd (last) quarter, waning crescent.
- Since the moon does not produce light, light from the sun reflects off the moon, enabling it to be seen from Earth.

The Phases of the Moon

- Waxing means "increasing."
- Waning means "decreasing."
- The moon does not produce its own light. It reflects sunlight in all directions.
- During a ***new moon***, the moon is between the sun and Earth, you cannot see the moon.

The Phases of the Moon

- After a few days, as the moon orbits Earth, , it is no longer between the sun and Earth.
- A little part of the moon's face reflects sunlight toward Earth= waxing (increasing) crescent.
- When ***half*** of the moon's bright side faces Earth, it is a ***first quarter moon.***
- During a ***waxing gibbous***, most of the moon's lighted side faces Earth.

The Phases of the Moon

- When the moon is half way through its cycle, the side that faces Earth is opposite of the sun. Earth sees all of the moon's bright face. This is called a ***full moon***.
- As the cycle continues, we see less and less of the bright side of the moon.
- In decreasing order, ***waning gibbous, third quarter moon, waning crescent.***
- After ***29.5 days***, the cycle is complete. Another ***new moon*** has appeared.

Quick Check

The position of what objects is responsible for the moon's phases?

A. only Earth
B. only the moon and Earth
C. only the moon and the sun
D. the moon, Earth, and the sun

Quick Check

About how long does it take the moon to complete one cycle of phases?

A. one day
B. one week
C. one month
D. one year

Quick Check

Which is the correct order of the moon's phases?

A. waxing crescent, waning crescent, first quarter

B. waning gibbous, last quarter, waxing gibbous

C. full moon, new moon, first quarter

D. waxing gibbous, full moon, waning gibbous

Quick Check

How much of the moon's surface can you see during a new moon phase?

A. none
B. one-quarter
C. one half
D. all of it

Quick check

What phase of the moon would you see about three weeks after a new moon?

A. full moon
B. waning gibbous
C. last quarter
D. the next new moon

Quick Check Answer

What phase of the moon would you see about three weeks after a new moon?

C. last quarter

Solar and Lunar Eclipse Terms

- Lunar eclipsesolar eclipse
- Total eclipsepartial eclipse

How does Earth, the moon, and the sun align during a solar eclipse and lunar eclipse?

- What causes solar and lunar eclipses?
- Why do lunar eclipses occur only at full moon?
- Describe the relative positions of Earth, the sun, and the moon during a solar eclipse and during a lunar eclipse.

Solar and Lunar Eclipses

- A solar and lunar eclipse occurs only when the earth, moon, and sun are directly lined up.
- There are two types of eclipses.
- The moon goes dark during a lunar eclipse.
- The sun goes dark during a solar eclipse.
- A lunar eclipse occurs when Earth passes directly between the sun and the moon. The Earth casts a shadow on the moon.

Lunar and Solar Eclipses

- A lunar eclipse can happen only during full moon. This is because it is the only time when Earth, the sun, and the moon are directly lined up with the Earth between the moon and the sun.
- A solar eclipse occurs when the moon passes directly between the sun and Earth. The moon casts a shadow on a part of Earth's surface.
- A solar eclipse can happen only during a new moon. This is because it is the only time when Earth, the sun, and the moon are directly lined up with the moon between Earth and the sun.

Solar and Lunar Eclipses

- There is not a lunar or solar eclipse every month because the moon is not always on the same plane as Earth and the sun.
- The moon orbits Earth at an angle.
- An eclipse can be total or partial.
- A total eclipse occurs when the moon or sun becomes completely covered.
- A partial eclipse occurs when the moon or sun becomes only partly covered.

Quick Check

Under what conditions will an eclipse take place?

A. only when the sun and Earth are directly lined up

B. only when the moon and Earth are directly lined up

C. only when the moon, the sun, and Earth are not exactly lined up

D. only when the moon, the sun, and Earth are directly lined up

Quick Check

What phase must the moon be in to allow for a lunar eclipse?

A. new
B. full
C. first quarter
D. waxing gibbous

Quick Check

Although the moon is much smaller than the sun, it looks about the same size when viewed from Earth. What fact might account for this observation?

A. The moon is farther from Earth than the sun.
B. Earth is closer to the sun than the moon
C. The moon is closer to Earth than the sun.
D. The moon shines brighter than the sun.

Quick Check

What conditions would produce a partial eclipse of the moon?

A. the moon is on the same plane as the sun and Earth

B. the moon is below the plane of the sun and Earth

C. the moon is far above the plane of the sun and Earth

D. none of the above

Quick Check

When Earth's shadow falls on the moon, the shadow causes a

A. new moon.
B. solar eclipse.
C. full moon.
D. lunar eclipse.

The Tilt of Earth Terms

- Earth’s tilt23.5°
- summer solsticeautumnal equinox
  - (June 21st)(Sept. 22nd)
- winter solsticevernal equinox
  - (Dec. 21st)(March 21st)

Why does Earth have a cycle of seasons?

- What two factors cause the cycle of seasons?
- How is Earth's axis tilted when the Northern Hemisphere has summer?
- What does the word equinox mean? How is it related to the position of Earth's axis?

The Tilt of Earth

- Earth's axis is tilted from its orbit around the sun by 23.5°.
- Earth has seasons because its axis is tilted as it moves around the sun.
- As Earth revolves around the sun, its axis is tilted away from the sun part of the year and toward the sun for part of the year.
- The cycle of seasons is caused by Earth's revolution around the sun and the tilt of Earth's axis.

The Tilt of Earth

- ***Summer solstice*** (June 21)is the first day of summer in the Northern Hemisphere. At this time, Earth's North Pole is tilted a full 23.5° toward the sun. This Hemisphere of Earth has its longest day.

- ***Autumnal equinox*** (Sept. 22) signals the first day of autumn. At this point, Earth is neither pointed toward or away from the sun.

- All parts of Earth have days and nights that are almost equal in length.

The Tilt of Earth

- ***Winter solstice*** (Dec. 21) is the first day of winter in the Northern Hemisphere and is a point in Earth's orbit. Earth's North Pole is tilted a full 23.5° away from the sun.
- Sunlight strikes areas north of the equator at a greater angle than at any other time of the year.
- Days are the shortest and nights are the longest.

The Tilt of Earth

- ***Vernal equinox*** (March 20) marks the first day of spring in the Northern Hemisphere.
- At this time, Earth is not tilted toward or away from the sun.
- Days and nights are of equal length.

Seasons on Earth

- At the equator, sunlight hits Earth's surface more directly or at smaller angles.
- Closer to the poles, sunlight hits Earth's surface at greater angles. Near the poles, energy from the sun is spread out over a greater area.
- For this reason, areas near the equator have a very warm climate, and areas farther from the equator have cooler climates.
- Areas farthest from the equator have the coldest climate since sunlight strikes these areas at the greatest angle.

Quick Check

On the first day of which season, or seasons, in the Northern Hemisphere is Earth neither tilted toward or away from the sun?

A. winter
B. spring and autumn
C. only spring
D. summer

Quick Check

What is the season in the Southern Hemisphere of Earth when it is summer in the Northern Hemisphere?

A. spring
B. autumn
C. winter
D. summer

Quick Check

On which of the following dates is the Northern Hemisphere of Earth tilted away from the sun at the greatest angle?

A. March 20
B. June 21
C. September 22
D. December 21

Quick Check

At what angle is Earth tilted on its axis?

A. 0°
B. 23.5°
C. 45°
D. 90°

Quick Check

About how many hours of daylight would you expect people in Chicago to experience on February 1?

A. 10

B. 12

C. 14

D. 16