GEOGRAPHY

SAMPLE HANDOUT
Basics of Geography

NEEV 2023

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Basics of Geography

1

"Because there is a law such as gravity, the universe can and will create itself from nothing."

-- Stephen Hawking

1.1 Universe

The universe refers to *all of space and everything in it*. It contains everything that exists, from the smallest particles to the largest structures known. The *exact size of the universe is not known*.

The universe encompasses everything in existence, from the smallest atom to the largest galaxy. It is estimated that it contains about 100 billion **galaxies**.

The universe is currently estimated at roughly **13.7 billion years old**. In comparison, the solar system is only about 4.6 billion years old. This estimate came from measuring the composition of matter and energy density in the universe.

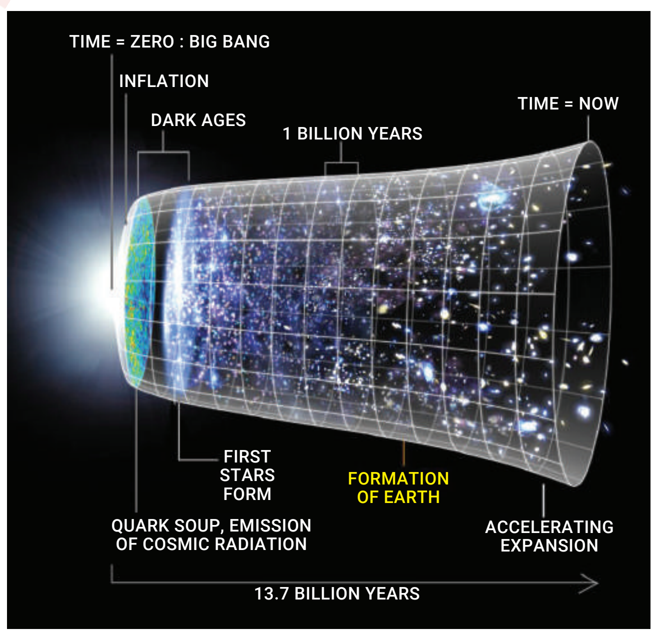
The universe contains many components, which vary considerably in size. The smallest components are **atomic particles** followed by atoms (mostly free hydrogen and helium), molecules, **dust, space rocks, comets, asteroids, moons, dwarf planets, planets, solar systems, stars, black holes, nebulae and galaxies**.

Among these components the solar system is the most known with certainty.

Atoms only make up **4.6 percent** of the universe. Of the remainder, **23 percent** is made up of **dark matter**, which is likely composed of one or more species of subatomic particles that interact very weakly with ordinary matter, and **72 percent** is made of **dark energy**, which apparently is driving the accelerating expansion of the universe.

1.1.1 Origin of Universe

The broadly accepted theory for the origin and evolution of our universe is the **Big Bang model**, which states that the universe began as an incredibly hot, dense point roughly **13.7 billion years ago**.



According to the Big Bang theory, the **universe was born as a very hot, very dense, single point in space.**

When the universe was very young — it underwent an incredible growth spurt. During this **burst of expansion**, which is known as **inflation**, the *universe grew exponentially and doubled in size* at least 90 times.

Light chemical elements were created within the first three minutes of the universe's formation. As the universe expanded, temperatures cooled and protons and neutrons collided to make deuterium, which is an isotope of hydrogen. Much of this deuterium combined to make helium.

About 380,000 years after the Big Bang, matter cooled enough for electrons to combine with nuclei to form neutral atoms. This phase is known as **recombination**, and the *absorption of free electrons caused the universe to become transparent*. It was followed by a **period of darkness** before stars and other bright objects were formed.

Roughly 400 million years after the Big Bang, the universe began to come out of its dark ages. This period in the universe's evolution is called the **age of re-ionization**.

During this time, *clumps of gas collapsed enough to form the very first stars and galaxies*. The emitted ultraviolet light from these energetic events cleared out and destroyed most of the surrounding neutral hydrogen gas. **The process of re-ionization, plus the clearing of foggy hydrogen gas, caused the universe to become transparent to ultraviolet light for the first time**.

In the 1960s and 1970s, astronomers inferred that there might be more mass in the universe than simply what is visible.

The mysterious and invisible mass thought to be causing this phenomenon became known as **dark matter**. Dark matter is pretty well-defined as **some kind of material that has mass but doesn't interact with light**, which is why we're having trouble seeing it.

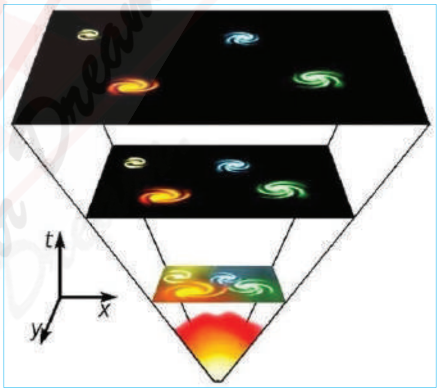
Since dark matter has mass, it is **governed by gravity**. So, while dark matter is invisible, it is **inferred based on the gravitational pull it exerts on regular matter**. Dark matter is thought to make up **23 percent of the universe**, while only 4 percent of the universe is composed of regular matter, such as stars, planets and humans.

1.1.2 Expanding Universe

The Big Bang Theory is also called **expanding universe hypothesis**.

Edwin Hubble, in 1920, provided evidence that the universe is expanding. As time passes, galaxies move further and further apart.

You can experiment and find what the expanding universe means - Take a balloon and mark some points on it to represent the galaxies. Now, if you start inflating the balloon, the points marked on the balloon will appear to be moving away from each other as the balloon expands. Similarly, the distance between the galaxies is also found to be increasing and thereby, the universe is considered to be expanding. However, you will find that besides the increase in the distances between the points on the balloon, the points themselves are expanding. This is not in accordance with the fact. Scientists believe that though the space between the galaxies is increasing, observations do not support the expansion of galaxies. So, the balloon example is only partially correct.



Even though the universe is expanding it **does not mean expansion of galaxy or movement of galaxies through space**. The galaxies sit more or less passively in the space around them. As the space between galaxies expands, it carries the galaxies further apart.

Hubble showed that galaxies are receding away from us with a velocity that is proportional to their distance from us: *more distant galaxies recede faster than nearby galaxies*. This relation is the well-known **Hubble Law**.

It indicates a constant expansion of the cosmos where galaxies recede from each other at a constant speed per unit distance; thus, more distant objects move faster than nearby ones.

Although the expansion rate is constant in all directions at any given time, this rate changes with time throughout the life of the universe.

Hubble measured the **redshifts** of a number of distant galaxies. He also measured their relative distances by measuring the apparent brightness of a class of variable stars called **Cepheids** in each galaxy. He found that the redshift of distant galaxies increased as a linear function of their distance. The only explanation for this observation is that the universe was expanding.

A star's intense radiation causes the electrons of atoms near its surface to change their orbital positions and absorb radiation at discrete frequencies. Each element produces a unique set of spectral absorption lines, like a barcode, which can be compared with standard measurements to calculate the amount of red shift. This is analogous to the Doppler effect a vehicle's sound changing frequency as it moves towards or away from you. *The increase in red light suggests that the stars are moving away from us*.

The expanding universe is finite in both time and space. The reason that the universe did not collapse, as Newton's and Einstein's equations said it might, is that it had been expanding from the moment of its creation. The universe is in a constant state of change.

In 2019, fresh evidence suggested that the universe is expanding faster today than it did in its infancy.

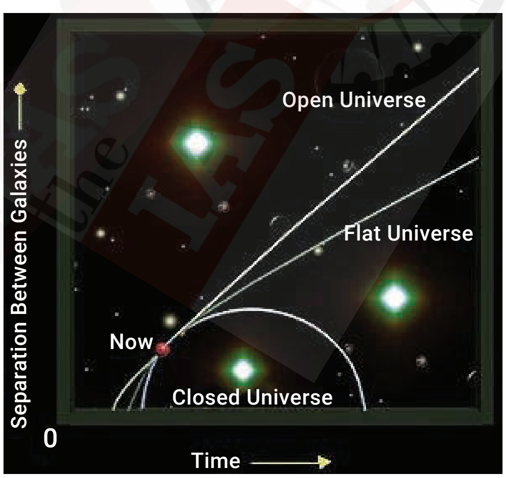
A. Properties of the expanding universe

The three possible types of expanding universes are called open, flat, and closed universes.

i. If the universe were **open**, it would expand forever.

ii. If the universe were **flat**, it would also expand forever, but the expansion rate would slow to zero after an infinite amount of time.

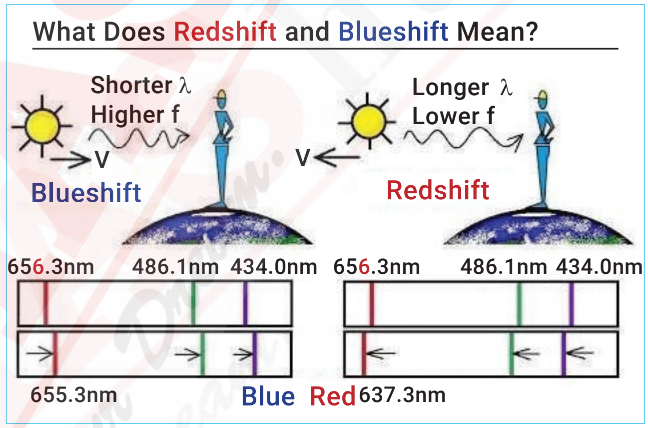
iii. If the universe were **closed**, it would eventually stop expanding and re-collapse on itself, possibly leading to another big bang. In all three cases, the expansion slows, and the force that causes the slowing is gravity.



B. Redshift and Blueshift

Redshift and blueshift describe how light shifts toward shorter or longer wavelengths as objects in space (such as stars or galaxies) move closer or farther away from us. The concept is key to charting the universe's expansion.

Visible light is a spectrum of colours. When an object moves away from us, the light is shifted to the red end of the spectrum, as its wavelengths get longer. If an object moves closer, the light moves to the blue end of the spectrum, as its wavelengths get shorter



1.1.3 Galaxy

A galaxy is a huge collection of gas, dust and billions of stars and their solar systems. A galaxy is held together by gravity.

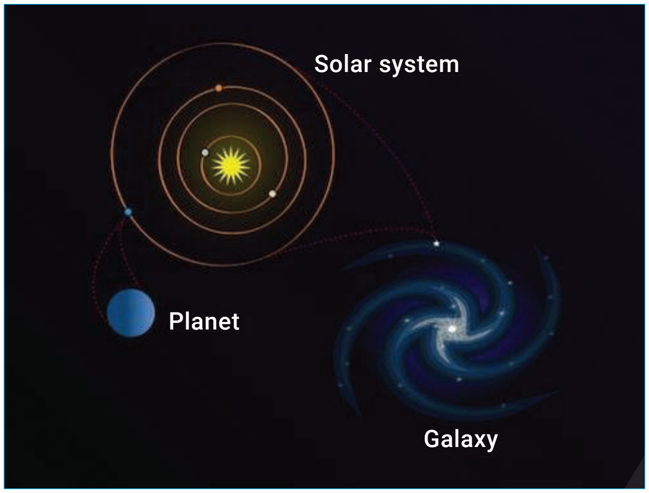
The light that we see from galaxies comes from the stars inside it.

Nearly all large galaxies are thought to also contain supermassive black holes at their centers.

In our own galaxy, the **Milky Way**, the sun is just one of about 100 to 400 billion stars that spin around **Sagittarius A***, a supermassive black hole that contains as much mass as four million suns.

One 2016 study estimated that the observable universe contains two trillion—galaxies. Some of those distant systems are similar to our own Milky Way galaxy, while others are quite different.

Sometimes galaxies get too close and smash into each other. The Milky Way galaxy will someday bump into **Andromeda**, our closest galactic neighbor.



Stars are huge celestial bodies **made mostly of hydrogen and helium** that produce light and heat from the churning nuclear forges inside their cores.

It's impossible to know how many stars exist, but astronomers estimate that in our Milky Way galaxy alone, there are about 300 billion.

The life cycle of a star spans billions of years. As a general rule, the more massive the star, the shorter its life span.

Birth of a star takes place inside hydrogen-based dust clouds called **nebulae**. Over the course of thousands of years, gravity causes pockets of dense matter inside the nebula to collapse under their own weight. One of these contracting masses of gas, known as a **protostar**, represents a star's nascent phase.

As a protostar gets smaller, it spins faster because of the conservation of angular momentum. Increasing pressure creates rising temperatures and during this time, a star enters what is known as the relatively brief **T Tauri phase**.

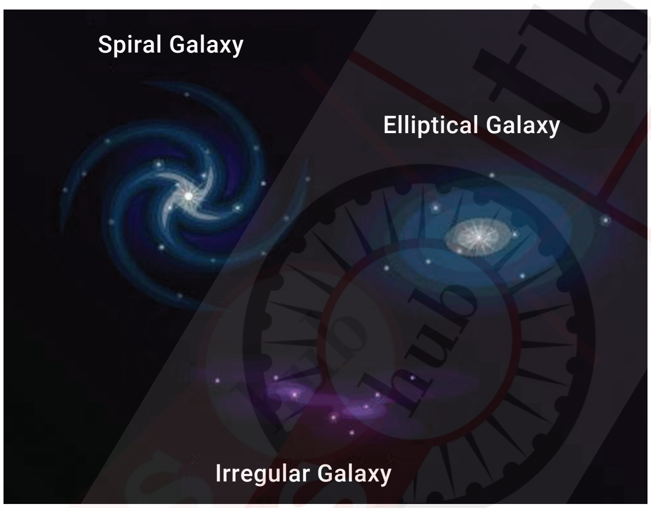
Millions of years later, when the core temperature climbs to about 27 million degrees Fahrenheit (15 million degrees Celsius), **nuclear fusion** begins, igniting the core and setting off the next - and longest - stage of a star's life, known as its **main sequence**.

Most of the stars in our galaxy, including the sun, are categorized as main sequence stars. They exist in a stable state of nuclear fusion, **converting hydrogen to helium and radiating x-rays**. This process emits an enormous amount of energy, keeping the star hot and shining brightly.

Some stars shine more brightly than others. Their brightness is a factor of how much energy they put out, known as luminosity and how far away from Earth they are.

Types of Galaxies

1. Some galaxies are **spiral-shaped** like Milky Way. They have curved arms that make it look like a pinwheel.
2. Other galaxies are smooth and oval shaped. They're called **elliptical galaxies**.
3. There are also galaxies that aren't spirals or ovals. They have **irregular shapes** and look like blobs.



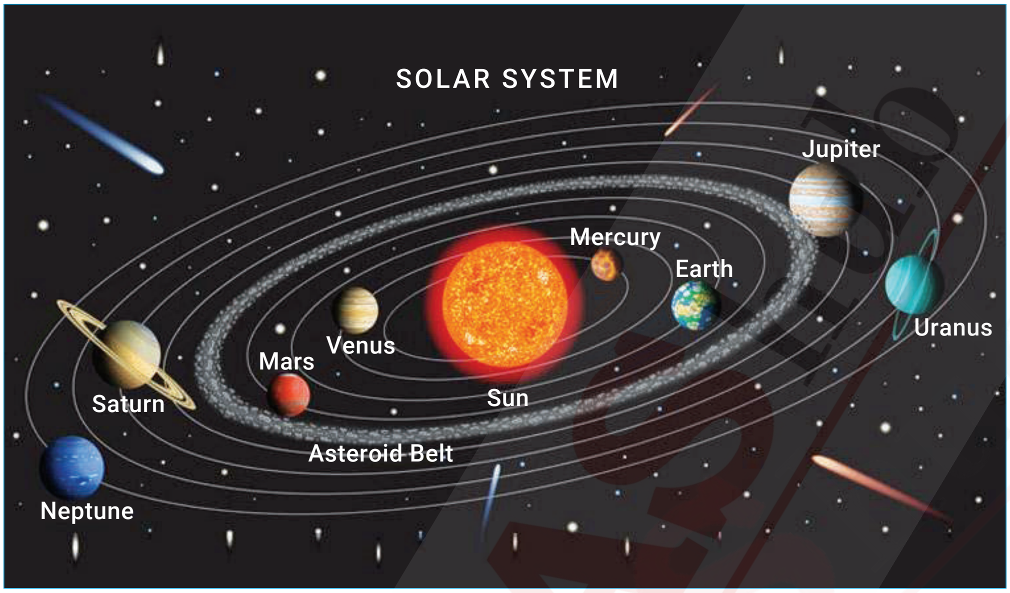
1.1.4 Stars

Stars are the most widely recognized astronomical objects, and represent the most **fundamental building blocks** of galaxies. The age, distribution and composition of the stars in a galaxy trace the history, dynamics and evolution of that galaxy. Moreover, stars are responsible for the **manufacture and distribution of heavy elements** such as carbon, nitrogen and oxygen.

1.2 Solar System

There are many planetary systems like ours in the universe, with planets orbiting a host star. Our planetary system is named the 'solar' system because our Sun is named Sol, after the Latin word for Sun, 'solis', and anything related to the Sun we call 'solar.'

Our solar system consists of star, the Sun and everything bound to it by gravity — the planets Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune, dwarf planets such as Pluto, dozens of moons and millions of asteroids, comets and meteoroids.



1.2.1 Size of Solar System

Our solar system extends much farther than the eight planets that orbit the Sun. The solar system also includes the **Kuiper Belt** that lies past Neptune's orbit.

Kuiper Belt is a sparsely occupied ring of icy bodies, almost all smaller than the most popular Kuiper Belt Object, dwarf planet Pluto. Beyond the fringes of the Kuiper belt is the **Oort cloud**.

Oort Cloud is a giant spherical shell surrounds our solar system. The Oort cloud is made of icy pieces of space debris the sizes of mountains and sometimes larger, orbiting our Sun as far as 1.6 light years away. The Oort cloud is the boundary of the Sun's gravitational influence, where orbiting objects can turn around and return closer to our Sun.

1.2.2 Origin of Solar System

Our solar system formed about 4.5 billion years ago from a dense cloud of interstellar gas and dust.

The cloud collapsed, possibly due to the **shockwave** of a nearby exploding star, called a **supernova**. When this dust cloud collapsed, it formed a **solar nebula**—a spinning, swirling disk of material.

At the center, gravity pulled more and more material in. Eventually the pressure in the core was so great that hydrogen atoms began to combine and form helium, releasing a tremendous amount of energy. With that, our Sun was born, and it eventually amassed more than 99 percent of the available matter.

Matter farther out in the disk was also clumping together. These clumps smashed into one another, forming larger and larger objects.

Some of them grew big enough for their gravity to shape them into spheres, becoming planets, dwarf planets and large moons.

In other cases, planets did not form: the **asteroid belt** is made of bits and pieces of the early solar system that could never quite come together into a planet. Other smaller leftover pieces became asteroids, comets, meteoroids, and small, irregular moons.

1.2.3 Structure

The order and arrangement of the planets and other bodies in our solar system is due to the way the solar system formed.

Nearest the Sun, only rocky material could withstand the heat when the solar system was young. For this reason, the first four planets—Mercury, Venus, Earth and Mars—are terrestrial planets. They're small with solid, rocky surfaces.

Meanwhile, materials we are used to seeing as ice, liquid or gas settled in the outer regions of the young solar system. Gravity pulled these materials together, and that is where we find gas giants Jupiter and Saturn and ice giants Uranus and Neptune.

1.2.4 Sun

The Sun is our closest star. The diameter of the Sun is 1,392,000 kilometers.

It is believed to be over 4 billion years old.

The Sun spins slowly on its axis as it revolves around the galaxy. It takes 25 days to turn once on its axis.

The Sun is a large ball of gas consisting mostly of hydrogen and helium.

The Sun is about 109 times larger than Earth

The center or core, of the Sun is very hot.

The temperature in its core is estimated to be over 15,000,000 degrees Celsius.

1.2.5 Planets

According to International Astronomical Union (IAU), planets and other bodies, except satellites, in our Solar System be defined into three distinct categories in the following way:

1. A **planet** is a celestial body that with the following three conditions:
    i. It is in orbit around the Sun.
    ii. It has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape.
    iii. It has cleared the neighbourhood around its orbit.
2. A **dwarf planet** is a celestial body that must fullfill following four conditions:
    i. It is in orbit around the Sun.
    ii. It has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape.
    iii. It has not cleared the neighbourhood around its orbit.
    iv. It is not a satellite.

3 All other objects, except satellites, orbiting the Sun shall be referred to collectively as Small Solar System Bodies.

International Astronomical Union (IAU)

IAU was founded in 1919.

Its mission is to promote and safeguard the science of astronomy in all its aspects, including research, communication, education and development, through international cooperation.

Its individual Members — structured into Divisions, Commissions, and Working Groups — are professional astronomers from all over the world, at the Ph.D. level and beyond, who are active in professional research, education and outreach in astronomy.

1.2.6 Inner and Outer Planets

The inner four planets closest to the sun — **Mercury, Venus, Earth and Mars** — are often called the **terrestrial planets** because their **surfaces are rocky**. Pluto also has a rocky, albeit frozen, surface but has never been grouped with the four terrestrials.

The four large **outer planets** — **Jupiter, Saturn, Uranus and Neptune** — are sometimes called the **Jovian** or 'Jupiter-like' planets because of their *enormous size relative to the terrestrial planets*. They are also mostly **made of gases like hydrogen, helium and ammonia** rather than of rocky surfaces.

Jupiter and Saturn are sometimes called the **gas giants**, whereas the more distant **Uranus and Neptune** have been nicknamed the **ice giants**. This is because *Uranus and Neptune have more atmospheric water and other ice-forming molecules*, such as **methane, hydrogen sulfide** and **phosphene**, that crystallize into clouds in the planets' frigid conditions

Difference

Inner Planets	Outer Planets
Small and Rocky	Large and Gaseous
Solid Surface	No solid Surface
Low Mass	High Mass
High Density	Low Density
Close to Sun	Far from Sun
Closely spaced Orbits	Separated Orbits
Few Moons (if any)	Many Moons
No Rings	Many Rings
Terrestrial Planets	Gas Giants
Mercury, Venus, Earth and Mars	Jupiter, Saturn, Uranus and Neptune

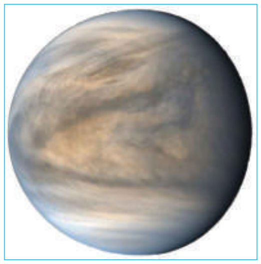
A. Mercury

Mercury is the nearest planet to the Sun.

Mercury takes 58.65 Earth days to complete its rotation (on its axis) and takes 88 days to complete its one revolution (i.e. in its orbit around the Sun).

Mercury is the fastest planet and it has no moon (satellite).

B. Venus



Venus is nearly as big as the Earth with a diameter of 12,104 km.

Venus is thought to be made up of a **central iron core, rocky mantle and silicate crust**.

A day on the surface of Venus (solar day) would appear to take 117 Earth days. A year on Venus takes 225 Earth days.

Venus' thick atmosphere makes it the hottest planet in our solar system. The surface temperature on Venus can reach 471 °C.

Venus has no satellite and it spins in the opposite direction of the Earth's spin.

Venus is named after the Roman goddess of Beauty.

C. Earth

Earth is the third planet from the Sun. By the time, Earth is the only planet where life exists.

Earth takes 23 hours, 56 minutes, and 40 seconds to complete its rotation (on its axis) and takes 365.26 days to complete its one revolution (i.e. in its orbit around the Sun).

Earth is 93 million mile away from sun.

It has diameter of 7926 miles.

The major atmospheric components of the Earth are Nitrogen (78%), Oxygen (20.95%), Argon (0.930%), and Carbon Dioxide (0.039%).

It has one natural satellite called moon.

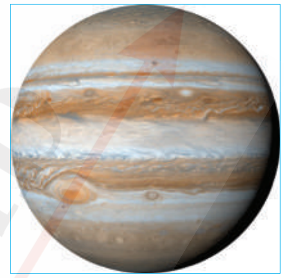
D. Mars

Mars is known as the 'Red Planet' of the solar system.

Mars takes 24 hours, 37 minutes, and 30 seconds to complete its rotation (on its axis) and takes 687 days to complete its one revolution (i.e. in its orbit around the Sun).

Mars has **two satellites** namely **Phobos (means fear) and Deimos (means terror)**.

E. Jupiter



It is largest planet in the solar system.

It is composed of **helium and hydrogen**.

It has a diameter of 88729 miles.

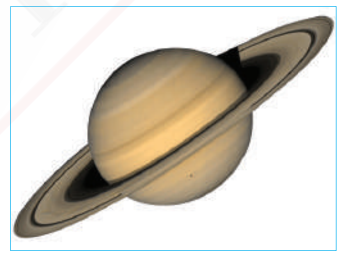
Jupiter takes 9 hours, 50 minutes, and 30 seconds to complete its rotation (on its axis)

Takes 12 earth years to complete its one revolution.

Jupiter has 79 natural satellites/moon.

Jupiter's *dark red spot is a storm larger than Earth*.

F. Saturn



Saturn is the largest planet after Jupiter in the solar system.

Saturn is popular for its spectacular rings system.

It is composed of liquid and gas.

It has a diameter of 74600 miles.

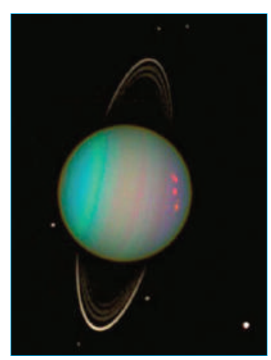
Saturn has the brightest, most massive and most complex ring system of any planet.

The rings system of Saturn is made up of a variety of separate particles that rotate in circular orbits independently.

Saturn takes 10 hours and 14 minutes to complete its rotation (on its axis) and takes 30 years to complete its one revolution (i.e. in its orbit around the Sun

Recently, the discovery of **20 new moons of Saturn** has made S**aturn the planet with the highest number of moons (82)** against 79 moons of Jupiter.

G. Uranus



It is the 3rd largest planet on solar system.

Uranus was officially discovered by Sir William Herschel in 1781.

Uranus turns on its axis once every 17 hours, 14 minutes.

It has a diameter of 36,600 miles

Uranus makes one trip around the Sun every 84 Earth years.

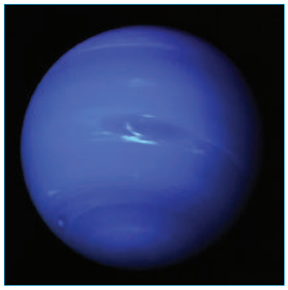
Uranus is often referred to as an 'ice giant' planet.

Uranus has two sets of very thin dark colored rings.

Uranus is tipped on its axis by almost 90-degrees.

H. Neptune

Neptune is the farthest planet which appears greenish through a telescope.

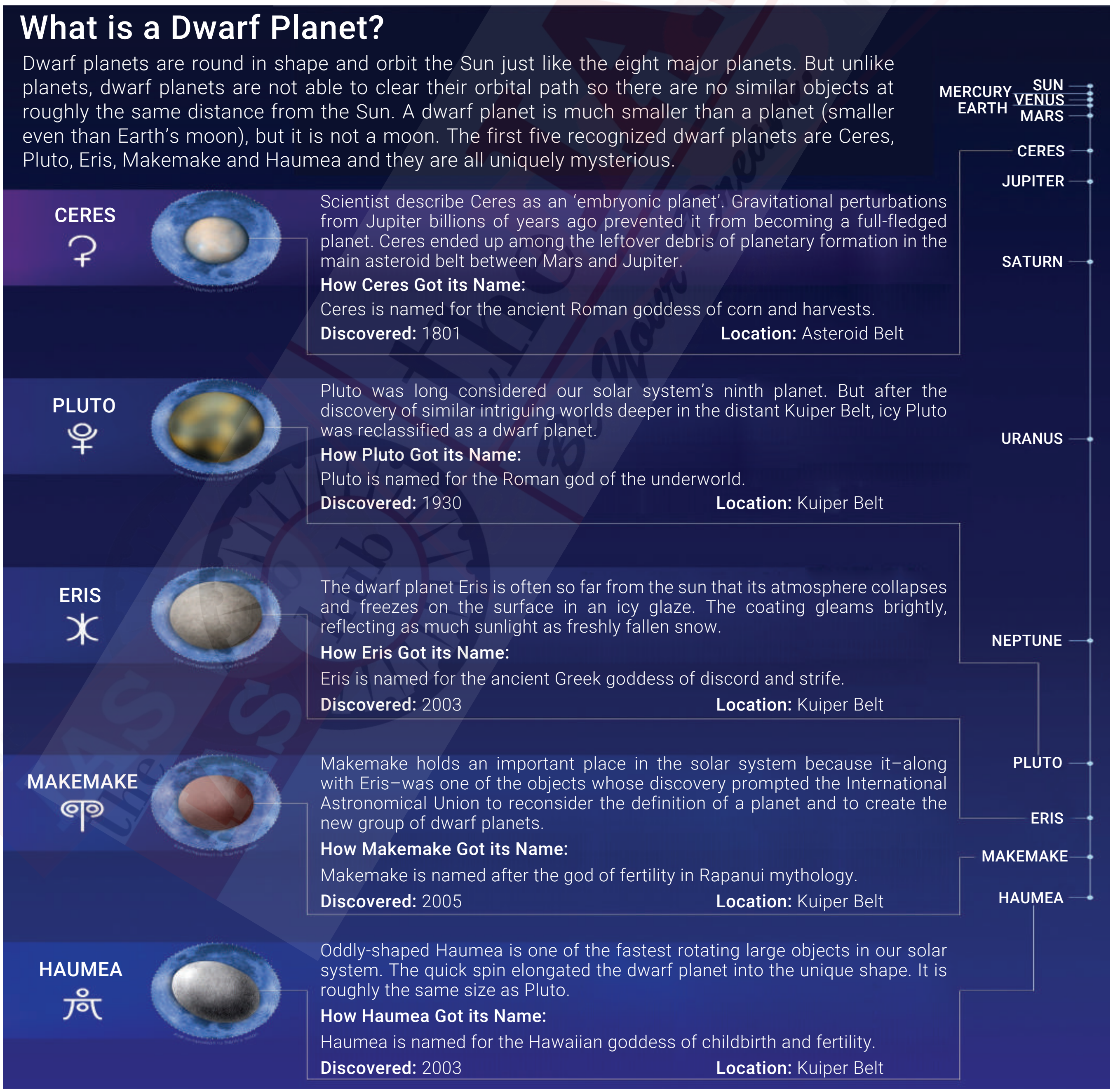


Neptune takes 18 hours to complete its rotation (on its axis) and takes 165 years to complete its one revolution (i.e. in its orbit around the Sun).

Neptune has 13 satellites/moons; significant of them are Triton and Nereid.

Until 2006, there were nine planets (including Pluto), but in 2006, the ninth planet Pluto was categorized as the dwarf planet by the International Astronomical Union (IAU).

1.2.7 Dwarf Planet



1.2.8 Other Interstellar Bodies

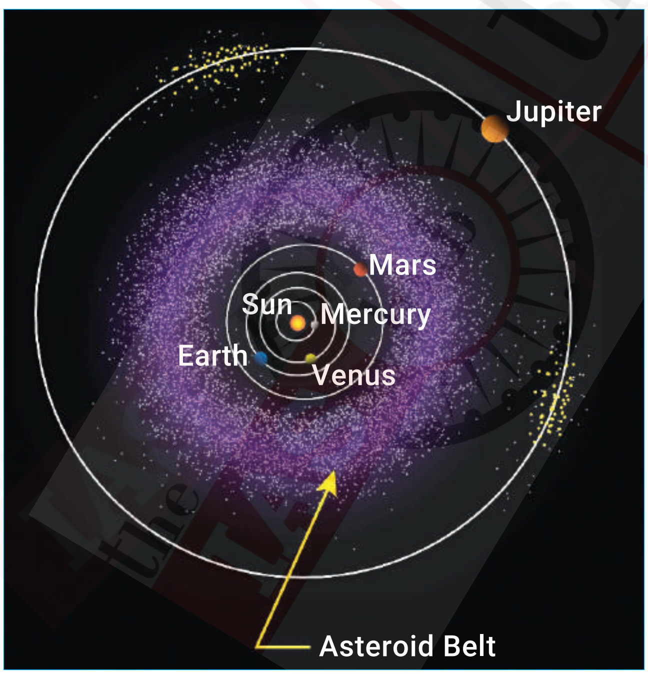
A. Asteroid

Asteroids, sometimes called **minor planets**, are rocky remnants left over from the early formation of our solar system about 4.6 billion years ago. The current known asteroid count is: 1,027,289.

Most of this ancient space rubble can be found orbiting the sun between Mars and Jupiter within the main **asteroid belt**. Asteroids range in size from **Vesta**—*the largest* at about 329 miles (530 kilometers) in diameter - to bodies that are less than 33 feet (10 meters) across. The total mass of all the asteroids combined is less than that of Earth's Moon.

Most asteroids are irregularly shaped, though a few are nearly spherical and they are often pitted or cratered. As they revolve around the sun in elliptical orbits, the asteroids also rotate.

More than 150 asteroids are known to have a small companion moon (some have two moons). There are also binary (double) asteroids, in which two rocky bodies of roughly equal size orbit each other, as well as triple asteroid systems.

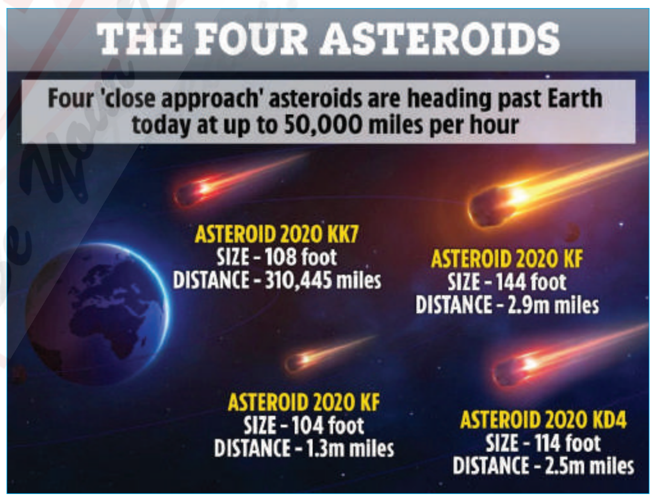


Composition: The three broad composition classes of asteroids are C, S and M - types.

1. The **C-type (chondrite)** asteroids are most common, probably consist of clay and silicate rocks and are dark in appearance. They are among the most ancient objects in the solar system.
2. The **S-types (stony)** are made up of silicate materials and nickel-iron.
3. The **M-types** are metallic (nickel-iron). The asteroids' compositional differences are related to how far from the sun they formed. Some experienced high temperatures after they formed and partly melted, with iron sinking to the center and forcing basaltic (volcanic) lava to the surface.

Trojans: These asteroids share an orbit with a larger planet, but do not collide with it because they gather around two special places in the orbit (called the L4 and L5 Lagrangian points). There, the gravitational pull from the sun and the planet are balanced by a trojan's tendency to otherwise fly out of the orbit.

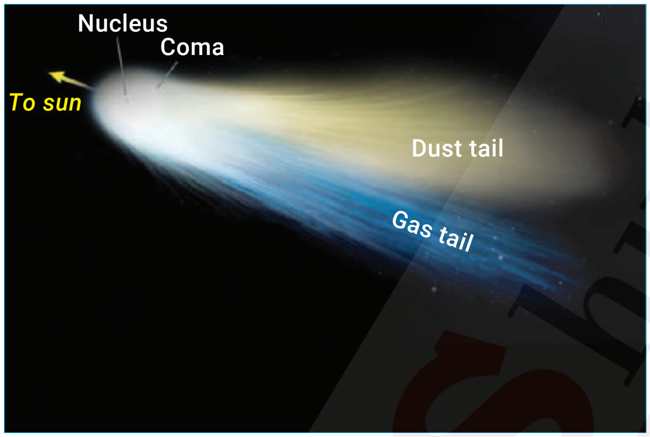
Asteroids are too small to have their own atmosphere. They revolve around the Sun, which varies from 3 to 10 years.



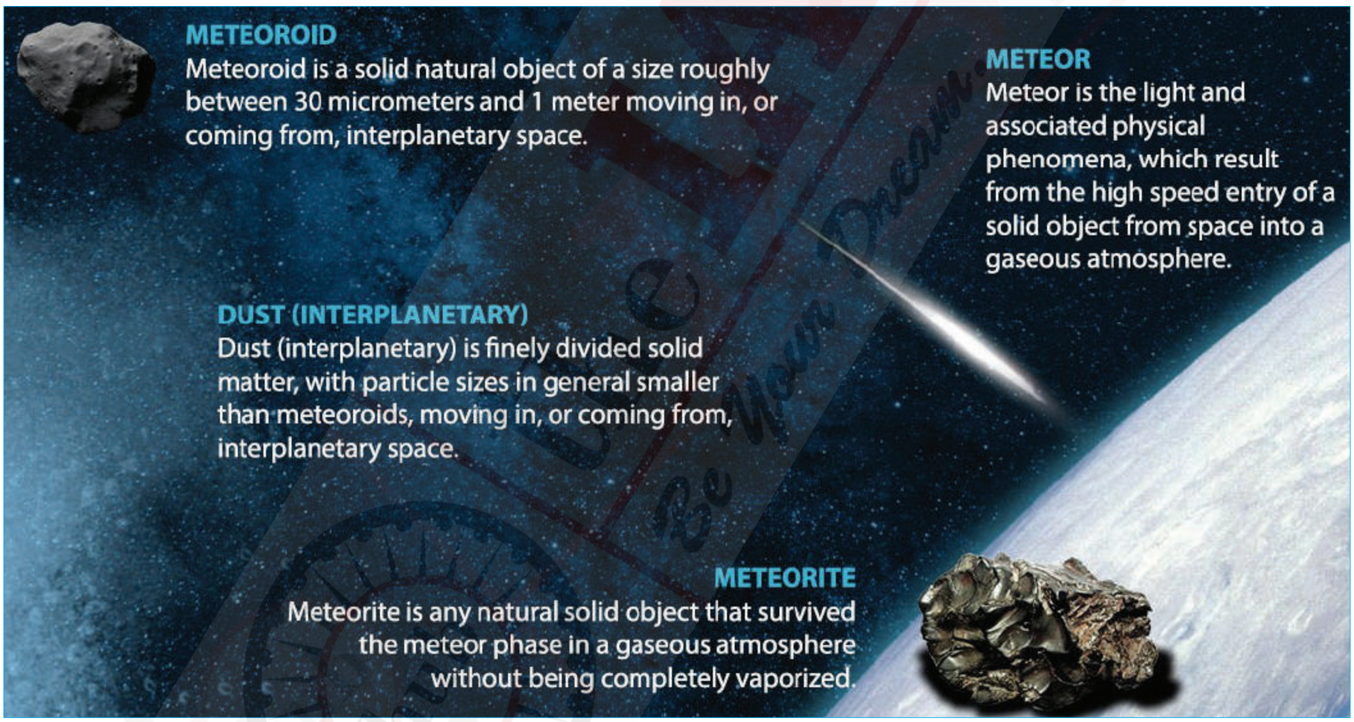
B. Comets

Comets are *frozen leftovers from the formation of the solar system composed of dust, rock and ices*. They range from a few miles to tens of miles wide, but as they orbit closer to the sun, they heat up and spew gases and dust into a glowing head that can be larger than a planet. This material forms a tail that stretches millions of miles.

There are likely billions of comets orbiting our Sun in the Kuiper Belt and even more distant Oort cloud. The current number of known comets is: 3,690.



C. Meteoroid, Meteor and Meteorite

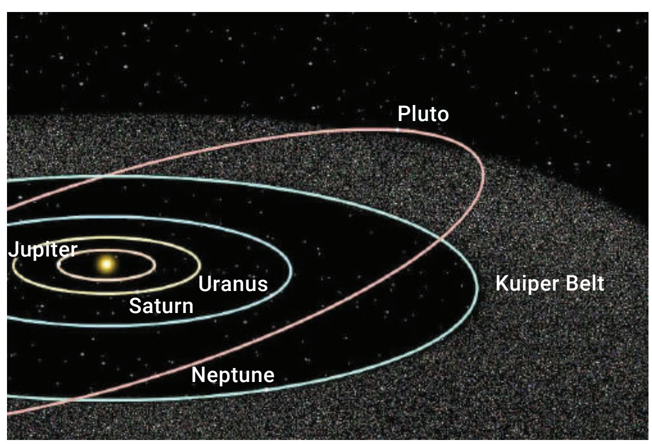


D. Kuiper Belt

Kuiper Belt or the **Kuiper-Edge worth Belt** is a doughnut-shaped region that extends between about three to eight billion miles (5 to 12 billion kilometers) out from the Sun (its inner edge is about at the orbit of Neptune, while its outer edge is about twice that diameter).

The Kuiper belt is home to three officially recognized dwarf planets: **Pluto, Haumea and Makemake**.

Kuiper Belt Objects: Kuiper Belt Objects (KBOs) are objects that originate from or orbit in the Kuiper Belt. The largest two Kuiper Belt objects are Pluto and Eris, with Pluto being slightly larger at a diameter of 2,377 kilometers (1,477 miles).

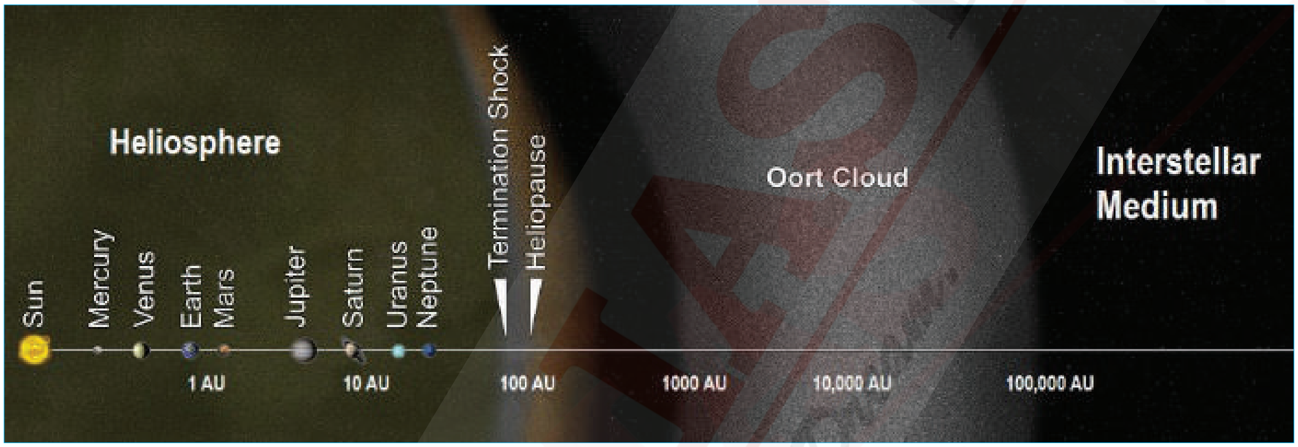


E. Oort Cloud

The Oort Cloud is the most distant region of our solar system. Even the nearest objects in the Oort Cloud are thought to be many times farther from the Sun than the outer reaches of the Kuiper Belt.

The Oort Cloud is believed to be a giant spherical shell surrounding the rest of the solar system. It is like a big, thick-walled bubble made of icy pieces of space debris the sizes of mountains and sometimes larger. The Oort Cloud might contain billions, or even trillions, of objects.

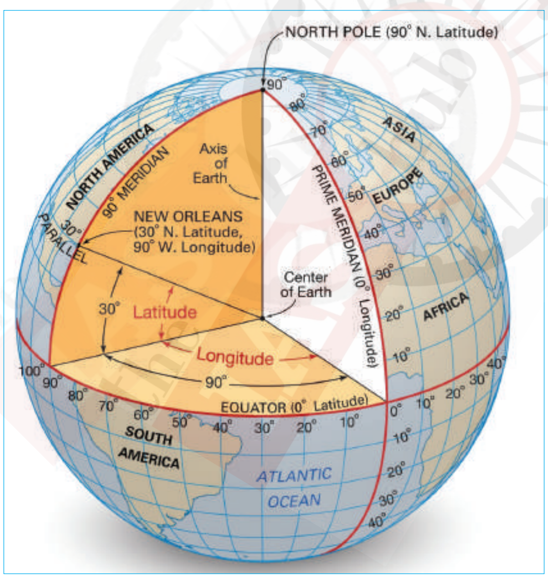
Because the orbits of long-period comets are so extremely long, scientists suspect that the Oort Cloud is the source of most of those comets. For example, comet C/2013 A1 Siding Spring, which made a very close pass by Mars in 2014, will not return to the inner solar system for about 740,000 years.

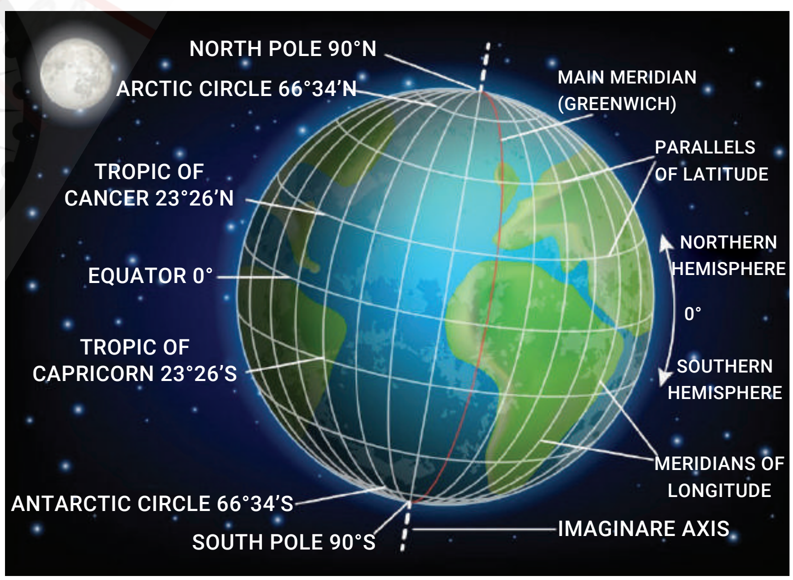


1.3 Latitude And Longitude

Latitudes and Longitudes are **imaginary lines** used to determine the location of a place on earth.

The shape of the earth is **Geoid** and the location of a place on the earth can be mentioned in terms of latitudes and longitudes. Example: The location of New Delhi is 28° N, 77° E.





1.3.1 Latitude

Latitude is the measurement (angular distance) of distance **north or south of the Equator**. It is measured with 180 imaginary lines that form circles around the Earth **east-west**, **parallel to the Equator**. These lines are known as parallels.

A circle of latitude is an imaginary ring linking all points sharing a parallel. *All latitude are concentric circle*.

The **Equator is the line of 0 degrees latitude**. Each parallel measures **one degree north or south** of the Equator, with 90 degrees north of the Equator and 90 degrees south of the Equator. The latitude of the North Pole is 90 degrees N, and the latitude of the South Pole is 90 degrees S.

Like the poles, some circles of latitude are named. The Tropic of Cancer, for instance, is 23 degrees 26 minutes 21 seconds N—23° 26' 21'' N. Its twin, the Tropic of Capricorn, is 23° 26' 21'' S. The tropics are important geographic locations that mark the northernmost and southernmost latitudes where the sun can be seen directly overhead during a solstice.

One degree of latitude, called an **arcdegree**, covers about **111 kilometers (69 miles)**. Because of the Earth's curvature, the farther the circles are from the Equator, the smaller they are. At the North and South Poles, arcdegrees are simply points.

Degrees of latitude are divided into 60 minutes. One minute of latitude covers about 1.8 kilometers (1.1 miles).

As the earth is slightly flattened at the poles, the linear distance of a degree of latitude at the pole is a little longer than that at the equator. For example at the equator (0°) it is 68.704 miles, at 45° it is 69.054 miles and at the poles it is 69.407 miles. The average is taken as 69 miles (111 km).

A. Important Parallels

Besides the equator (0°), the North Pole (90°N) and the South Pole (90° S), there are four important parallels of latitudes:

1. **Tropic of Cancer (23½° N) in the Northern Hemisphere:** The Tropic of Cancer marks the location where the sun reaches the zenith at this latitude. The summer solstice, which occurs on either June 20 or 21 of each year, marks the day on which the sun shines vertically over this parallel.
2. **Tropic of Capricorn (23½° S) in the Southern Hemisphere:** Moving every year, the Tropic of Capricorn is the parallel line of latitude. The winter solstice, which occurs on either December 21 or 22 of each year, marks the day on which the sun shines vertically over this line.
3. **Arctic Circle at 66½° north of the equator:** The region above the Arctic Circle, which includes the North Pole, is known as the Arctic.
4. **Antarctic Circle at 66½° south of the equator:** The region south of the Antarctic Circle, which includes the South Pole, is known as the Antarctic.

B. Heat Zones of the Earth

The mid-day sun is exactly overhead at least once a year on all latitudes in between the Tropic of Cancer and the Tropic of Capricorn. This area, therefore, receives the maximum heat and is called the **Torrid Zone**.

The mid-day sun never shines overhead on any latitude beyond the Tropic of Cancer and the Tropic of Capricorn. The angle of the sun's rays goes on decreasing towards the poles. As such, the areas bounded by the Tropic of Cancer and the Arctic Circle in the Northern Hemisphere, and the Tropic of Capricorn and the Antarctic Circle in the Southern Hemisphere, have moderate temperatures. These are, therefore, called **Temperate Zones**.

Areas lying between the Arctic Circle and the North Pole in the Northern Hemisphere and the Antarctic Circle and the South Pole in the Southern Hemisphere, are very cold. It is because here the sun does not rise much above the horizon. Therefore, its rays are always slanting and provide less heat. These are, therefore, called **Frigid Zones** (very cold).

1.3.2 Longitude

Unlike the parallels of latitude which are circles, the meridians of longitude are semi-circles that converge at the poles.

Longitude lines *run north-south* and *mark the position east-west* of a point. Lines of longitude are known as **meridians**. These lines run from pole to pole, crossing the equator at right angles.

There are 360 degrees of longitude and the longitude line of 0 degrees is known as the **Prime Meridian** and it divides the world into the Eastern Hemisphere and the Western Hemisphere (-180 degrees of longitude west and 180 degrees of longitude east).

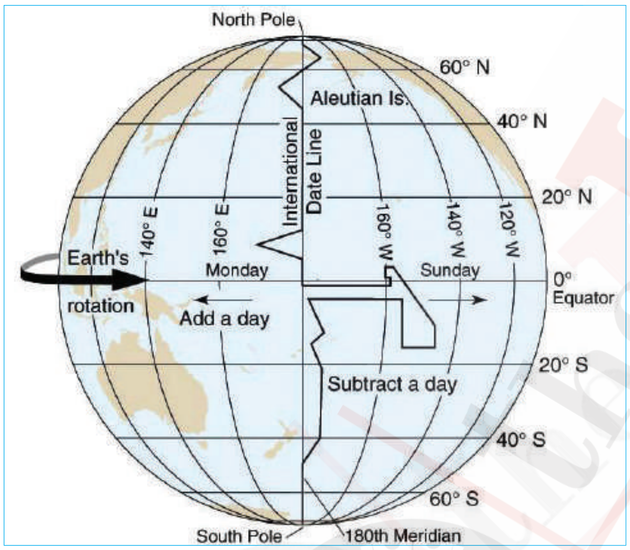
The distance between longitudes narrows the further away from the equator.

The distance between longitudes at the equator is the same as latitude, roughly 69 miles. At 45 degrees north or south, the distance between is about 49 miles (79 km).

The distance between longitudes reaches zero at the poles as the lines of meridian converge at that point.

Prime Meridian: The line of longitude where the degree is zero is known as the Prime Meridian. Passing through the *Royal Observatory, Greenwich, England*, it is also known as the *Greenwich Meridian* and *divides the earth into two equal halves known as the Eastern Hemisphere and the Western Hemisphere*.

1.3.3 International Date Line



The line on earth *where one calendar day becomes the next* is known as the International Date Line (IDL). The line is generally found 180 degrees from the Prime Meridian but the line circumvents some regions and islands to avoid dividing contiguous pieces of regions and countries into two separate days.

There are 23 one-hour slices and two 30 minutes slices that divide the world up into different time zones. *Traveling from east to west over the International Date Line advances the calendar by one day*.

A. Longitude and Time

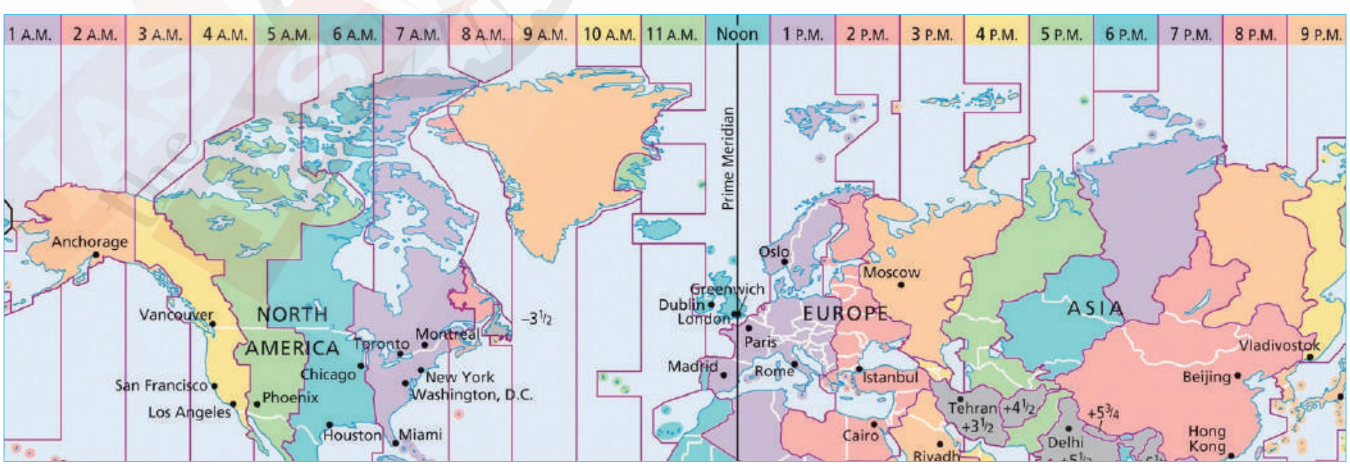
The best means of measuring time is by the movement of the earth, the moon and the planets. The sun regularly rises and sets every day, and naturally, it is the best time-keeper throughout the world.

Local time can be reckoned by the shadow cast by the sun, which is the shortest at noon and longest at sunrise and sunset. When the Prime Meridian of Greenwich has the sun at the highest point in the sky, all the places along this meridian will have mid-day or noon.

As the earth rotates from west to east, those places east of Greenwich will be ahead of Greenwich time and those to the west will be behind it.

The rate of difference can be calculated as - The earth rotates 360° in about 24 hours, which means 15° an hour or 1° in four minutes. Thus, when it is 12 noon at Greenwich, the time at 15° east of Greenwich will be 15*4 = 60 minutes, i.e., 1 hour ahead of Greenwich time, which means 1 p.m. But at 15° west of Greenwich, the time will be behind Greenwich time by one hour, i.e., it will be 11.00 a.m. Similarly, at 180°, it will be midnight when it is 12 noon at Greenwich.

At any place a watch can be adjusted to read 12 o'clock when the sun is at the highest point in the sky, i.e., when it is mid-day. The time shown by such a watch will give the local time for that place. You can see that all the places on a given meridian of longitude have the same local time.



B. Need for Standard Time

The local time of places which are on different meridians are bound to differ. For example, it will be difficult to prepare a time-table for trains which cross several longitudes.

In India, for instance, there will be a difference of about 1 hour and 45 minutes in the local times of Dwarka in Gujarat and Dibrugarh in Assam. It is, therefore, necessary to adopt the local time of some central meridian of a country as the standard time for the country.

In India, the longitude of 82° E (82° 30′ E) (in the city of Mirzapur Uttar Pradesh) is treated as the standard meridian. The local time at this meridian is taken as the standard time for the whole country. It is known as the Indian Standard Time (IST).

India located east of Greenwich at 82° 30′ E is 5 hours and 30 minutes ahead of GMT. So it will be 7:30 p.m. in India when it is 2:00 p.m. noon in London.

Some countries have a great longitudinal extent and so they have adopted more than one standard time. For example, in Russia, there are as many as eleven standard times. The earth has been divided into twenty-four time zones of one hour each. Each zone thus covers 15° of longitude.

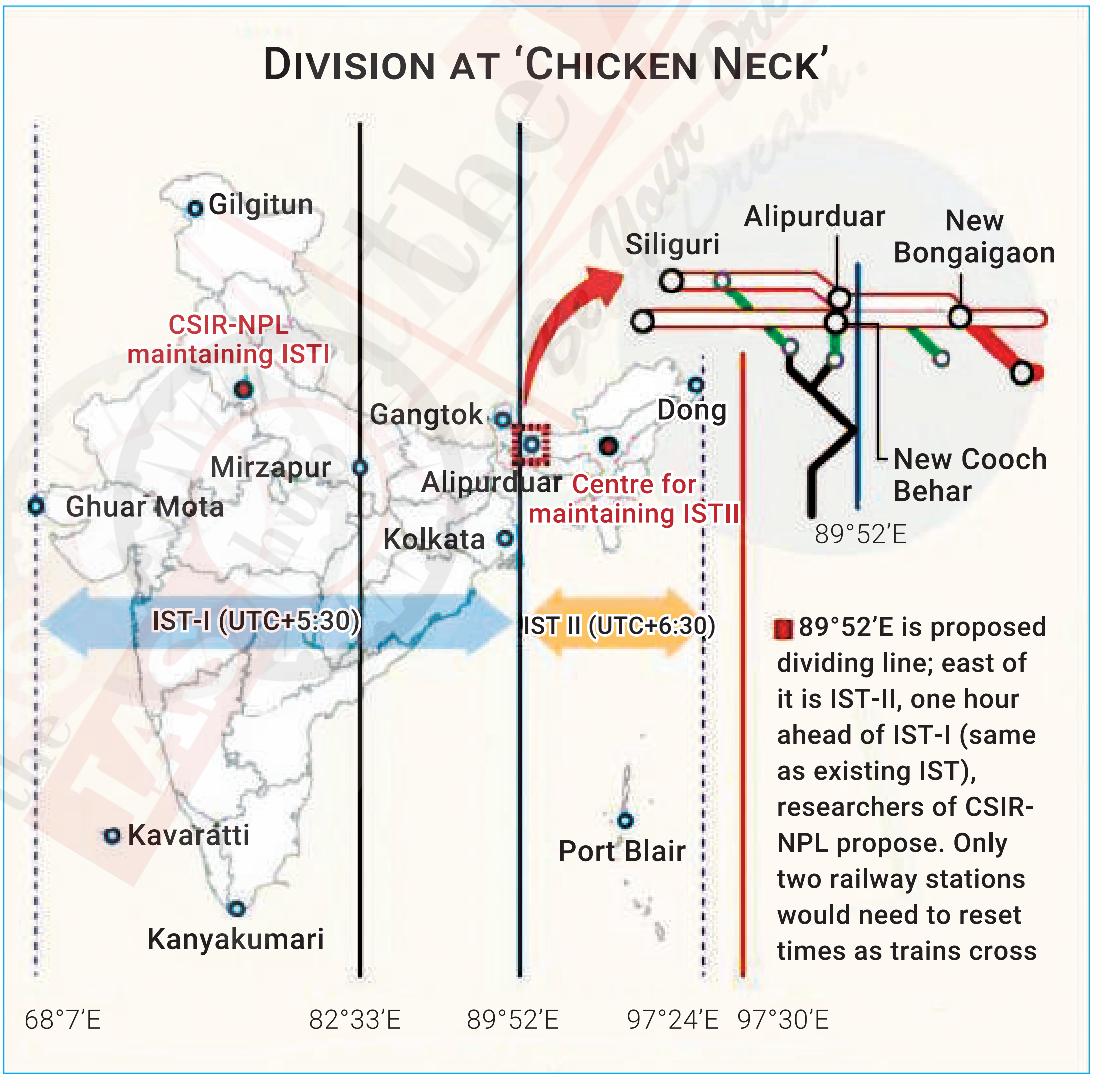
C. Day Light Saving

Daylight Saving Time (DST) is the **practice of turning the clock ahead as warmer weather approaches and back as it becomes colder again**.

The purpose of doing so is that people will have one more hour of daylight in the afternoon and evening during the warmer season of the year.

The daylight saving time is followed in over 70 countries on various dates.

India does not follow daylight saving time; countries near the Equator do not experience high variations in daytime hours between seasons



D. Chaibagaan Time

This was done to improve productivity by optimizing the usage of daytime. After Independence, Assam, along with the rest of India, has been following IST for the past 66 years.

The administration of the Indian state of Assam now wants to change it's time zone back to Chaibagaan time to conserve energy and improve productivity. Indian government didn't accept to such a proposal.

1.4. Shape of the earth

While the Earth appears to be round when viewed from the vantage point of space, it is actually closer to an ellipsoid. However, even an ellipsoid does not adequately describe the Earth's unique and ever-changing shape.

Our planet is pudgier at the equator than at the poles by about 70,000 feet. This is due to the centrifugal force created by the earth's constant rotation.

Mountains rising almost 30,000 feet and ocean trenches diving over 36,000 feet (compared to sea level) further distort the shape of the Earth. Sea level itself is even irregularly shaped.

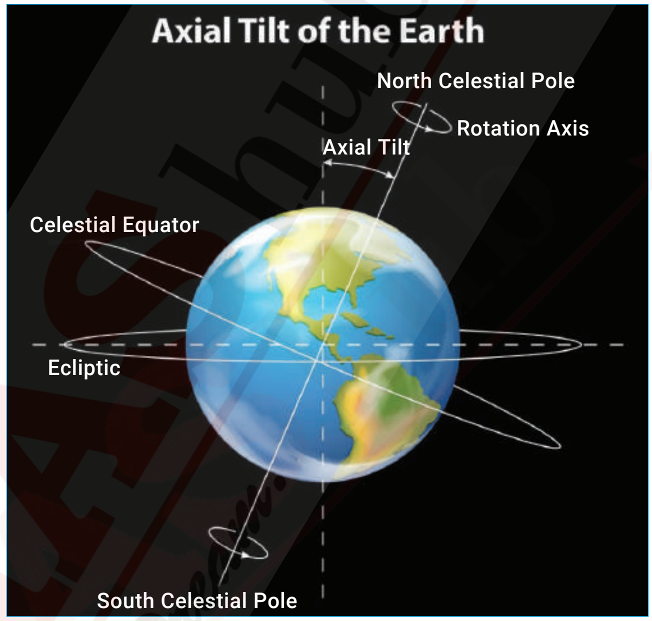
Slight variations in Earth's gravity field cause permanent hills and valleys in the ocean's surface of over 300 feet relative to an ellipsoid.

Additionally, the shape of the Earth is always changing. Sometimes this change is periodic, as is the case with daily tides that affect both the ocean and the crust; sometimes the change is slow and steady, as with the drift of tectonic plates or the rebound of the crust after a heavy sheet of ice has melted; and sometimes the shape of the planet changes in violent, episodic ways during events such as earthquakes, volcanic eruptions, or meteor strikes.

Geodesy is the science of measuring and monitoring the size and shape of the Earth, including its gravity field, and determining the location of points on the Earth's surface.

1.5 Rotation and Revolution of Earth

Imagine a line passing through the center of Earth that goes through both the North Pole and the South Pole. This imaginary line is called an **axis**. Earth's rotational axis makes an angle of **23.5°** with the normal i.e. it makes an angle of **66.5°** with the orbital plane. Orbital plane is the plane of earth's orbit around the Sun.



1.5.1 Earth's Rotation

Earth spins around its axis, this spinning movement is called Earth's rotation.

An observer in space will see that Earth requires 23 hours, 56 minutes, and 4 seconds to make one complete rotation on its axis. But because Earth moves around the Sun at the same time that it is rotating, the planet must turn just a little bit more to reach the same place relative to the Sun. Hence the length of a day on Earth is actually 24 hours. At the equator, the Earth rotates at a speed of about 1,700 km per hour, but at the poles the movement speed is nearly nothing.

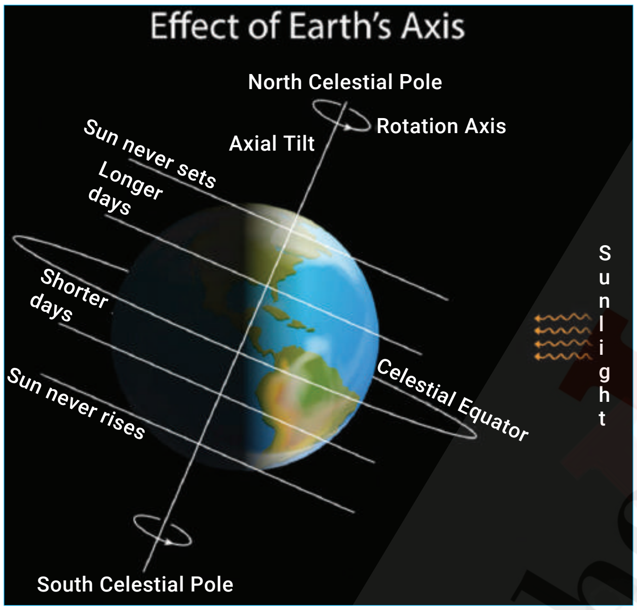
The change between day and night is caused by the rotation of the Earth on its axis. If the Earth did not rotate as it does, the day/night cycle would be very different or possibly even non-existent. The changing lengths of days and nights depends on where you are on Earth and the time of year. Also, daylight hours are affected by the tilt of the Earth's axis and its path around the sun.

A. Longer and Shorter Days

Although a solar day is 24 hours, not every day has 12 hours of daylight and 12 hours of night. Daytime is shorter in winter than in summer. This is because the Earth's imaginary axis isn't straight up and down, it is tilted 23.5 degrees.

As the Earth moves around the sun during a year, the northern half of the Earth is tilted towards the sun in the summer, making daytime longer than night.

In winter, this reverses; the earth tilts away from the sun and night time becomes longer. In the spring and fall, the tilt is neither toward or away from the sun but somewhere between, so day and night are more the same at these times of the year.

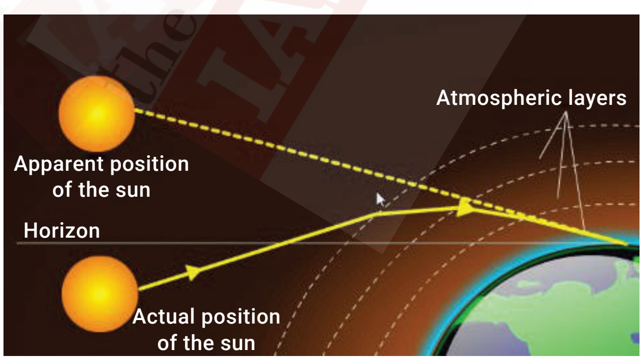


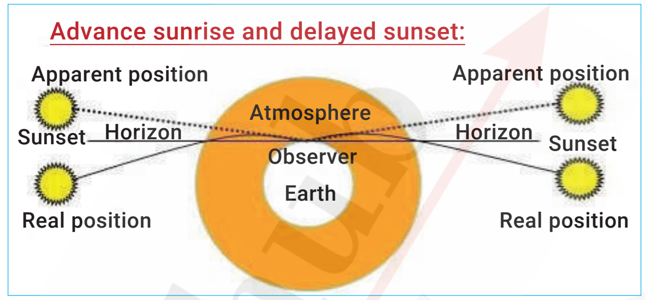
B. Why are days always longer than nights at the equator?

If there was no atmosphere, there would be no refraction and the daytime and night time would be near equal at the equator, at least during equinoxes.

But due to atmosphere, the sun's rays gets refracted (bending of light). Refraction is particularly stronger during the morning and the evening time when the sun's rays are slant.

Even though the actual sun is below the horizon, its apparent image would appear above the horizon due to refraction. This makes the days longer than nights at the equator.





C. Position on Earth

Your place on the Earth relative to the equator also affects the number of daylight hours you get in a solar day. For example, during summer in the Northern Hemisphere, daylight hours increase the farther north you go; at this time, the Arctic gets very little nighttime darkness. In the winter, daytime is shorter the farther north you go. The seasonal changes in daylight hours are small near the equator and more extreme close to the poles.

D. Why temperature falls with increasing latitude (as we move from equator towards poles)?

Because of the spherical (Geoid) shape of the earth and the position of the sun.

Because the energy received per unit area decreases from equator to poles.

Because Equator receives direct sunlight while Poles receive slant or oblique rays of the Sun.

1.5.2 Earth's Revolution

At the same time that the Earth spins on its axis, it also orbits, or **revolves around the Sun**. This movement is called revolution.

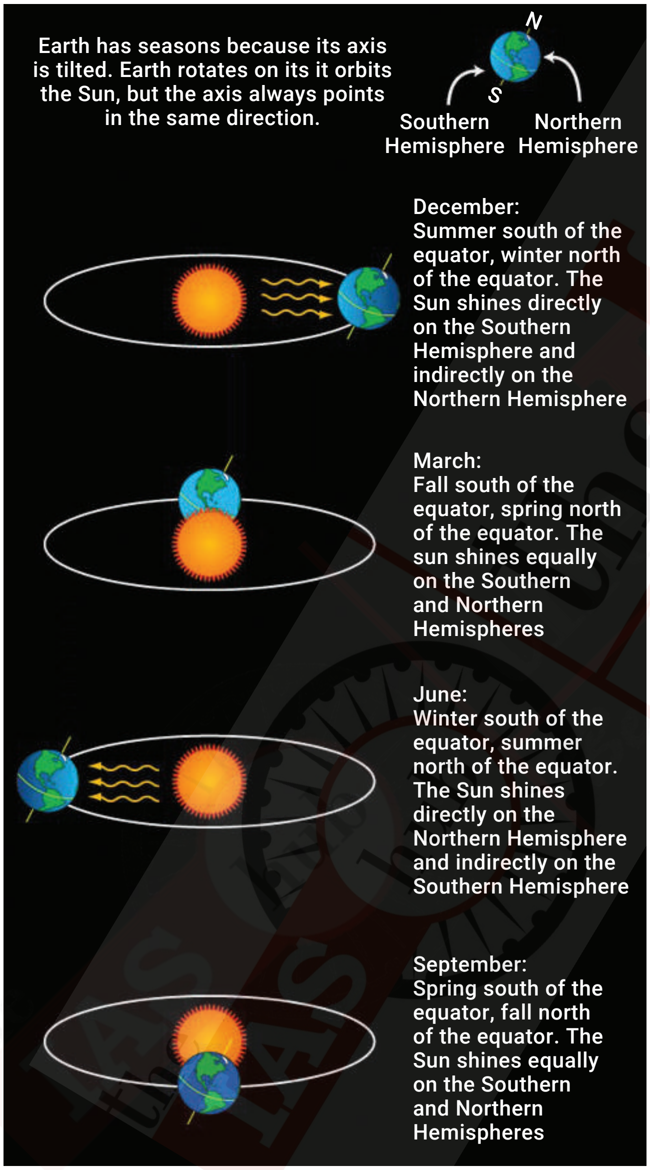
For Earth to make one complete revolution around the Sun takes 365.24 days. This amount of time is the definition of one year. Six hours saved every year are added to make one day (24 hours) over a span of four years. This surplus day is added to the month of February. Thus every fourth year, February is of 29 days instead of 28 days. Such a year with 366 days is called a leap year.

The gravitational pull of the Sun keeps Earth and the other planets in orbit around the star. Like the other planets, Earth's orbital path is an ellipse so the planet is sometimes farther away from the Sun than at other times.

1.5.3 Seasons on Earth

The reason the Earth (or any planet) has seasons is that Earth is tilted 23 ½ degree on its axis. During the Northern Hemisphere summer the North Pole points toward the Sun, and in the Northern Hemisphere winter the North Pole is tilted away from the Sun.

Earth's elliptical orbit has nothing to do with Earth's seasons. During one revolution around the Sun, Earth travels at an average distance of about 150 million km.



EXTRA BITS

Eccentricity

Eccentricity measures deviations in the Earth's elliptical (elongated) orbit from a symmetrical, circular orbit. If eccentricity is zero, an orbit is circular. As an orbit becomes more elliptical, its eccentricity gets closer to one. The two most important distances between the Earth and sun are described as perihelion, or the point in Earth's orbit when it's closest to the sun, and aphelion, or when its the farthest away. The difference between these distances is called eccentricity. The Earth's eccentricity varies from 0.0005 to 0.06, and the larger this number, the more solar radiation reaches the surface of the Earth. Eccentricity cycles last between 90,000 to 100,000 years.

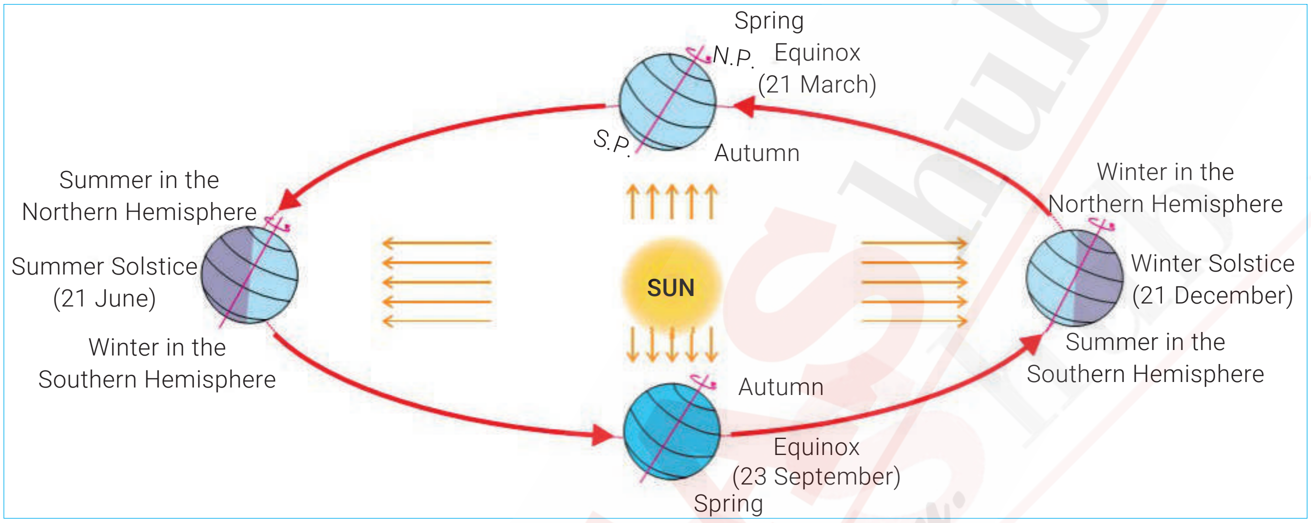
Obliquity

The angle of the Earth's axis is referred to as its obliquity. If the obliquity of the Earth equaled zero (no tilt at all), the Earth would have no seasons because no variation in temperature would occur. During the winter, the Northern Hemisphere (where most of the Earth's landmass is) is tilted away from the sun, receiving solar radiation at more of an angle. This results in colder temperatures and more extreme temperature changes. During the summer, the landmass is tilted toward the sun, resulting in warmer temperatures and less extreme changes. The cycles of obliquity last 40,000 years and the tilt itself varies from 22 to 24.5 degrees.

Precession

Precession describes the slight wobble in the Earth's axis caused by the moon and other planets in the solar system. Precession cycles change the times of perihelion and aphelion, causing increases and decreases in seasonal contrast. When a hemisphere is oriented toward the sun at perihelion, extreme differences in seasons result, and this pattern is reversed in the opposite hemisphere. The Earth's axis wobbles in cycles that last 26,000 years.

1.6 Solstice and Equinox



1.6.1 Solstice

The solstices are the positions of the Earth's orbit that mark the longest and shortest days of the year.

A. Summer Solstice

On **21st June**, the northern hemisphere is tilted towards the sun. The rays of the sun fall directly on the **Tropic of Cancer**. As a result, these areas receive more heat.

The areas near the poles receive less heat as the rays of the sun are slanting.

The North Pole is inclined towards the sun and the places beyond the Arctic Circle experience continuous daylight for about six months.

Since a large portion of the northern hemisphere is getting light from the sun, it is summer in the regions north of the equator. The **longest day and the shortest night** at these places occur on **21st June**.

At this time in the southern hemisphere all these conditions are reversed. It is winter season there. The nights are longer than the days. This position of the earth is called the **summer solstice**.

B. Winter Solstice

On **22nd December**, the Tropic of Capricorn receives direct rays of the sun as the South Pole tilts towards it.

As the sun's rays fall vertically at the **Tropic of Capricorn**, a larger portion of the southern hemisphere gets light. Therefore, it is summer in the southern hemisphere with longer days and shorter nights.

The reverse happens in the northern hemisphere. This position of the earth is called the **winter solstice**.

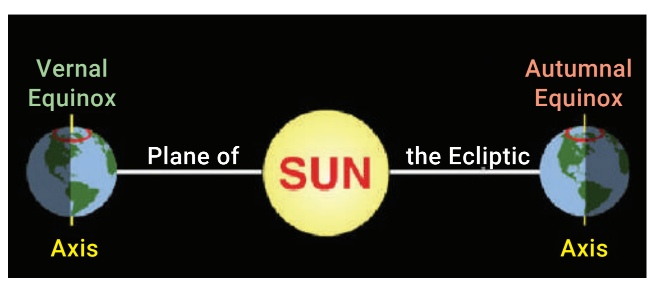
1.6.2 Equinox

On **21st March** and **September 23rd**, direct rays of the sun fall on the equator. At this position, neither of the poles is tilted towards the sun; so, the whole earth experiences equal days and equal nights. This is called an equinox.

On 23rd September, it is **autumn season (season after summer and before the beginning of winter)** in the northern hemisphere and **spring season (season after winter and before the beginning of summer)** in the southern hemisphere.

The opposite is the case on 21st March, when it is spring in the northern hemisphere and autumn in the southern hemisphere.

Thus, you find that there are **days and nights and changes in the seasons because of the rotation and revolution of the earth respectively**.



1.7 Perihelion and Aphelion

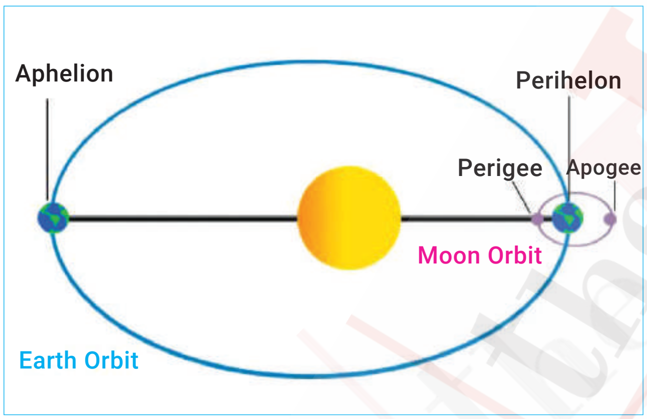
Earth travels 939,886,400 kms along its elliptical orbit in a single revolution.

The average distance is 150 million kms, but the orbit is elliptical and there is the difference if 2.5 million kms.

Perihelion: On around January 3rd, Earth is closest to sun and distance is around 147.5 million Kilometers. This is called Perihelion.

Aphelion: On about July 4th earth is Farthest from Sun and this is called Aphelion. The distance is 152.5 million Kms.

Speed of Earth is fastest at Perihelion and slowest at Aphelion (Kepler's Second Law).



Perigee and Apogee

The Moon's orbit periodically grows rounder and then more oval; it is never a perfect circle.

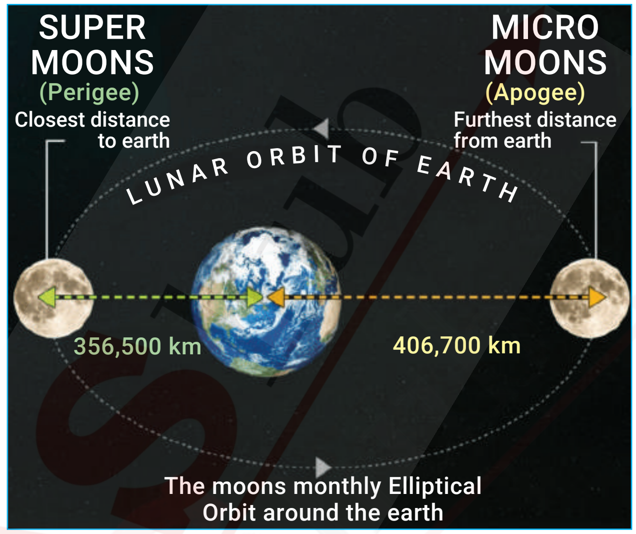
The point at which it is nearest Earth each month is called its **perigee** (this varies throughout the year).

The point at which the Moon is farthest from Earth each month is called its apogee (this varies throughout the year as well).

Perigee and apogee also affect the tides:

During the final quarter of the 20th century, the Moon was as close to Earth as 216,500 miles (surface to surface) at its most extreme perigee and as far away as 247,700 miles at its most extreme apogee.

At perigee, tidal ranges are increased; at apogee, they are decreased.



1.8 Eclipse

The earth, along with the other planets, revolves around the sun in its orbit.

In turn, the moon revolves around the earth in the moon's orbit.

There comes a time **when the three heavenly bodies get aligned in the same straight line. This is when an eclipse occurs**.

It is defined as an astronomical phenomenon that occurs when one spatial object comes within the shadow of another spatial object.

This obstructs the observer from seeing one of them in space. On earth, we witness two types of eclipses: solar and lunar.

Any object that obstructs light will produce two shadows: one which will be dark and dense, is called the umbra; and the other which is light and diffused is called the penumbra.

A. Lunar Eclipse

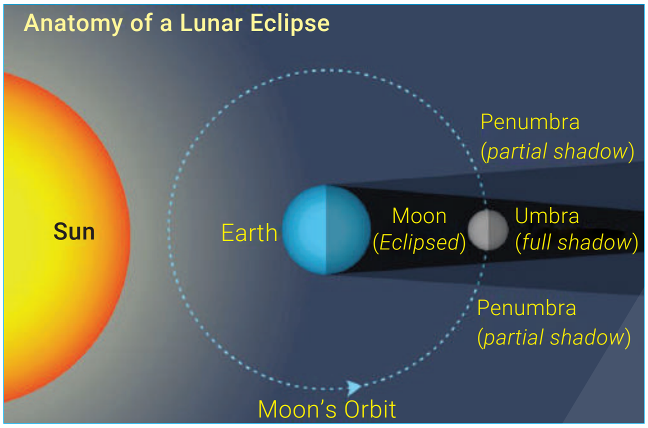
A lunar eclipse occurs when the **Moon moves into the Earth's shadow**.

This can occur only when the Sun, Earth, and Moon are exactly or very closely aligned with Earth between the other two.

A lunar eclipse can **occur only on the night of a full moon**. The type and length of a lunar eclipse depend on the Moon's proximity to either node of its orbit.

The only light reflected from the lunar surface has been refracted by Earth's atmosphere.

This light appears reddish for the same reason that a sunset or sunrise does: the Rayleigh scattering of bluer light. Due to this reddish color, a totally eclipsed Moon is sometimes called a blood moon.

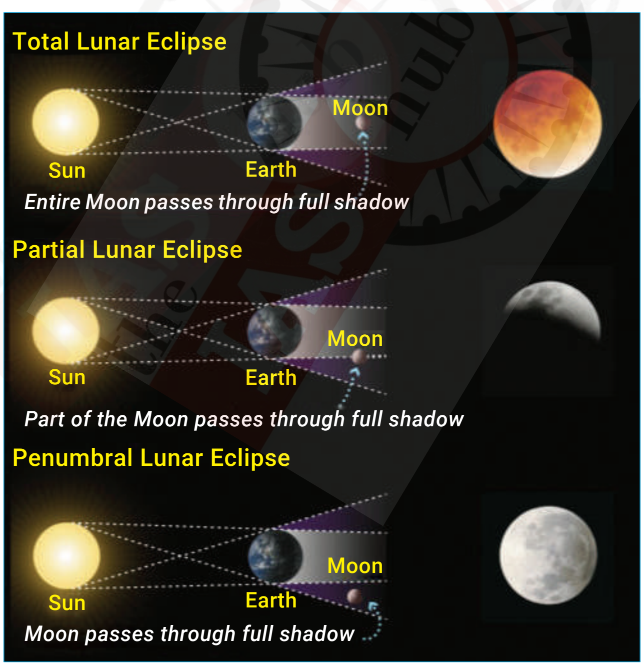


Types of Lunar Eclipse

i. **In a total eclipse of the moon**, the inner part of Earth's shadow, called the umbra, falls on the moon's face. At mid-eclipse, the entire moon is in shadow, which may appear blood red.

ii. **In a partial lunar eclipse**, the umbra takes a bite out of only a fraction of the moon. The dark bite grows larger and then recedes, never reaching the total phase.

iii. **In a penumbral lunar eclipse**, only the more diffuse outer shadow of Earth – the penumbra – falls on the moon's face. This third kind of lunar eclipse is much more subtle and much more difficult to observe than either a total or partial eclipse of the moon.



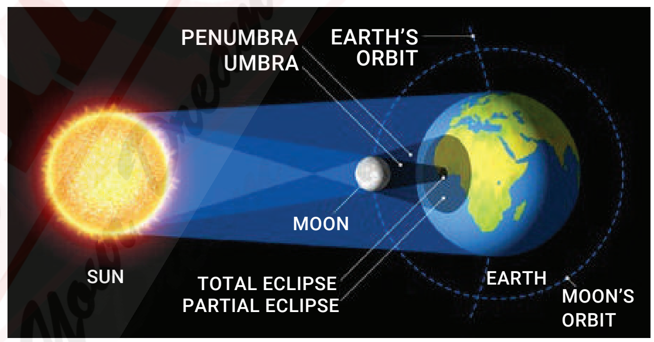
B. Solar Eclipse

A solar eclipse occurs **when the moon passes between the sun and the earth**. When this happens, the moon blocks the light of the sun from reaching the earth. The shadow of the moon is then cast on the earth.

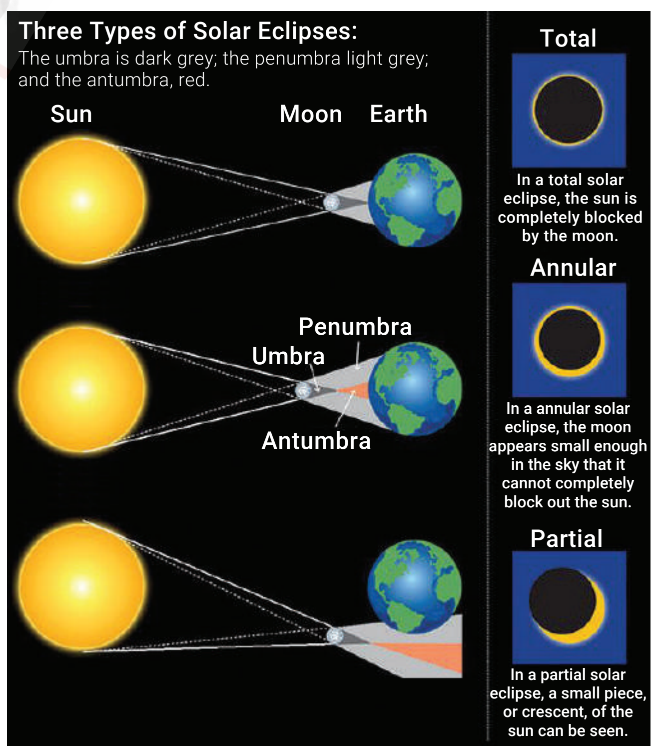
The moon also must be farther away from the earth, which will allow it to not cover the disc of the sun completely, resulting in a narrow band of light around the dark colour of the moon causing the ring of fire to be visible. Therefore, it is also called **the ring of fire eclipse**.

The distance between the earth and the moon at the moment of the eclipse can dictate the type of eclipse that will take place.

The distance between the earth and the moon is always changing due to the egg-shaped elliptical orbit of the moon.



Types of Solar Eclipse



There are **three types of solar eclipses**:

i. **Partial solar eclipse:** When the sun, moon and earth are not exactly lined up.

ii. **Total solar eclipse:** When the sun, moon and earth must be in a direct line.

iii. **Annular solar eclipse:** It is a particular type of total solar eclipse. It occurs when the sun, moon and earth are not only in a straight line but also in the same plane.

How lunar eclipse is different from Solar Eclipse?

A solar eclipse happens when the moon passes in between the earth and the sun.

A lunar eclipse happens when the earth passes in between the moon and the sun.

During a solar eclipse, the moon partially or fully hides the sun's rays for a few minutes.

Unlike a solar eclipse, which can only be viewed from a relatively small area of the world, a lunar eclipse may be viewed from anywhere on the night side of Earth.

Also unlike solar eclipses, lunar eclipses are safe to view without any eye protection or special precautions, as they are dimmer than the full Moon.

Prelims Grasp

1. Which of the following is/are cited by the scientists as evidence/evidences for the continued expansion of universe? [2012]

1. Detection of microwaves in space
2. Observation of red-shift phenomenon in space
3. Movement of asteroids in space
4. Occurrence of supernova explosions in space

Select the correct answer using the codes given below:

(a) 1 and 2 (b) 2 only
(c) 1, 3 and 4
(d) None of the above can be cited as evidence

2. The group of small pieces of rock revolving round the sun between the orbits of Mars and Jupiter are called: [1997]

(a) meteors (b) comets
(c) meteorites (d) asteroids

3. Consider the following statements regarding asteroids: [1998]

1. Asteroids are rocky debris of varying size orbiting the sun
2. Most of the asteroids are small but some have diameter as large as 1000 km
3. The orbit of asteroids lies between the orbits of Jupiter and Saturn

Of these statements

(a) 1, 2 and 3 are correct
(b) 2 and 3 are correct
(c) 1 and 2 are correct
(d) 1and 3 are correct

4. Match List-I with List-II and select the correct answer by using the codes given below the lists: [1998]

List-I (Special characteristic)	List-II (Name of planet)
A. Smallest planet of the solar system	1. Mercury
B. Largest planet of the solar system	2. Venus
C. Planet second from the Sun in the solar system	3. Jupiter
D. Planet nearest to the Sun	4. Pluto
	5. Saturn

Codes:

(a) A-2; B-3; C-5; D-1 (b) A-3; B-5; C-1; D-2
(c) A-4; B-1; C-2; D-3 (d) A-4; B-3; C-2; D-1

5. **A meteor is : [1995]**
   (a) a rapidly moving star
   (b) a piece of mater which has entered the earth's atmosphere from outer space
   (c) part of a constellation
   (d) a comet without a tail

6. **Which one of the following statements is correct with reference to our solar system? [2002]**
   (a) The earth is the densest of all the planets in our solar system
   (b) The predominant element in the composition of earth is silicon
   (c) The sun contains 75 percent of the mass of the solar system
   (d) The diameter of the sun is 190 times that of the earth

7. **Among the following which planet takes maximum time for one revolution around the Sun? [2003]**
   (a) Earth (b) Jupiter
   (c) Mars (d) Venus

8. **What is the average distance (approximate) between the sun and the earth? [2007]**
   (a) 70 × 105 km (b) 100 × 105 km
   (c) 110 × 106 km (d) 150 × 106 km

9. **In order of their distances from the Sun, which of the following planets lie between Mars and Uranus? [2008]**
   (a) Earth and Jupiter (b) Jupiter and Saturn
   (c) Saturn and Earth (d) Saturn and Neptune

10. **Which one of the following planets has largest number of natural satellites or moons? [2009]**
   (a) Jupiter (b) Mars
   (c) Saturn (d) Venus

11. **Diamond ring is a phenomenon observed: [1996]**
   (a) at the start of a total solar eclipse
   (b) at the end of a total solar eclipse
   (c) only along the peripheral regions of the totality trail
   (d) only in the central regions of the totality trail

12. **Variations in the length of daytime and night time from season to season are due to [2013]**
   (a) the earth's rotation on its axis
   (b) the earth's revolution round the sun in an elliptical manner
   (c) latitudinal position of the place
   (d) revolution of the earth on a tilted axis

13. **Along which one of the following meridians did India experience the first light of the sunrise of the new millennium? [2000]**
   (a) 2°30' W (b) 82°30' E
   (c) 92°30' W (d) 92°30' E

14. **If it is 10.00 am. I.S.T., then what would be the local time at Shillong on 92° E longitude? [1999]**
   (a) 9.38 a.m. (b) 10.38 a.m.
   (c) 10.22 a.m. (d) 9.22 a.m.

15. **The latitudes that pass through Sikkim also pass through : [2010]**
   (a) Rajasthan
   (b) Punjab
   (c) Himachal Pradesh
   (d) Jammu and Kashmir

16. **Among the following cities, which one lies on a longitude closest to that of Delhi? [2018]**
   (a) Bengaluru (b) Hyderabad
   (c) Nagpur (d) Pune

17. **Among the following cities, which one is nearest to the Tropic of Cancer? [2003]**
   (a) Delhi (b) Kolkata
   (c) Jodhpur (d) Nagpur

18. **Consider the following pairs: [2013]**
   1. Electromagnetic radiation
   2. Geothermal energy
   3. Gravitational force
   4. Plate movements

5. Rotation of the earth
6. Revolution of the earth

Which of the above are responsible for bringing dynamic changes on the surface of the earth?

(a) 1, 2, 3 and 4 only (b) 1, 3, 5 and 6 only
(c) 2, 4, 5 and 6 only (d) 1, 2, 3, 4, 5 and 6

19. If the stars are seen to rise perpendicular to the horizon by an observer, he is located on the: [2001]

(a) Equator (b) Tropic of cancer
(c) South pole (d) North pole

20. In the earth's direction of rotation is reversed, what should be the IST when it is noon at the International Date Line? [1997]

(a) 06.30 hrs. (b) 05.30 hrs.
(c) 18.30 hrs. (d) 17.30 hrs.

21. Assertion (A): The same face of the moon is always presented to the earth.

Reason (R): The moon rotates about its own axis in 23 and half days which is about the same time that it takes to orbit the earth.

Choose the appropriate codes from below: [2005]

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

22. Assertion (A): To orbit around the Sun the planet Mars takes lesser time than the time taken by the earth.

Reason (R): The diameter of the planet Mars is less than that of earth. **[2006]**

Codes:

(a) Both 'A' and 'R' are individually true and 'R' is the correct explanation of 'A'.
(b) Both 'A' and 'R' are individually true but 'R' is not the correct explanation of 'A'.
(c) 'A' is true but 'R' is false.
(d) 'A' is false but 'R' is true.

23. Who amongst the following was the first to state that the earth was spherical? [2001]

(a) Aristotle (b) Copernicus
(c) Ptolemy (d) Strabo

24. Consider the following statements: The Earth's magnetic field has reversed every few hundred thousand years. When the Earth was created more than 4000 million years ago, there was 54% oxygen and no carbon dioxide. When living organisms originated, they modified the early atmosphere of the Earth. Which of the statements given above is/are correct? [2018]

(a) 1 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Mains Grasp

1. What is the 'diamond ring effect' observed during a total solar eclipse? How is it caused? (1979)

2. Why have Saturn's Titan been in the news recently? (2011)

3. Write a note on origin of Earth and the planets in solar system .also examine how scientist study birth of planets in universe.

4. What are the difference Between Rotation and Revolution?

5. Rotation of the earth and Its Impact.

6. What are the different type of eclipse?

7. Discuss about solstice and there effects.

Answers

(1) a	(2) d	(3) c	(4) d	(5) b	(6) a	(7) b	(8) d	(9) b	(10) a	(11) c	(12) d
(13) d	(14) b	(15) a	(16) a	(17) b	(18) d	(19) a	(20) c	(21) c	(22) d	(23) a	(24) c