INDEX

WORLD GEOGRAPHY

TOPIC 1

ORIGIN OF GEOGRAPHY

Origin Of Geography

Eratosthenes, a 3rd century B.C. chief librarian at the famous Library of Alexandria, is credited as the first person to use the word "geography". He is commonly called "the father of geography". Alexander von Humboldt is commonly called the "father of modern geography" and William Morris Davis is commonly called the "father of American geography".

Most likely, Eratosthenes was not the first person to use the basic perspective of geography, the spatial perspective. In Eratosthenes day people already were undertaking the exploration of land and water areas of the Middle East and were carrying on trade across the Mediterranean Sea as well as across vast expanses of desert. Knowledge of how to get to some place and ultimately to return home was crucial to the sailors involved in loftier goals of measurement of earth's size, calculation of distances, and creation of a geometric system for accurately defining location. Eratosthenes is given credit for making the first accurate determination of the size of earth.

The word geography is derived from Greek and literally means "to write about the earth". Geography is an all-encompassing discipline that seeks to understand the world- its human and physical features- through an understanding of place and location. Geographers study where thing are and how they got there. Geography looks at the spatial connection between people, places, and the earth.

By understanding the connection between the environment and people, geography ties together diverse sciences as geology, biology, and climatology with economics, history, and politics based on location.

Branches Of Geography

- **Human Geography**

  Many branches of geography are found within human geography, a major branch of geography that studies people and their interaction with the earth and with their organization of space on the earth's surface

- **Economic Geography**

  Economic geographers examine the distribution of production and distribution of goods, the distribution of wealth, and the spatial structure of economic conditions.

- **Population Geography**

  Population geography is often equated with demography but population geography is more than just patterns of birth, death, and marriage. Population geographers are concerned with the distribution, migration, and growth of population in geographic areas.

- **Medical Geography**

  Medical geographers study the geographic distribution of disease (including epidemics and pandemics), illness, death and health care.

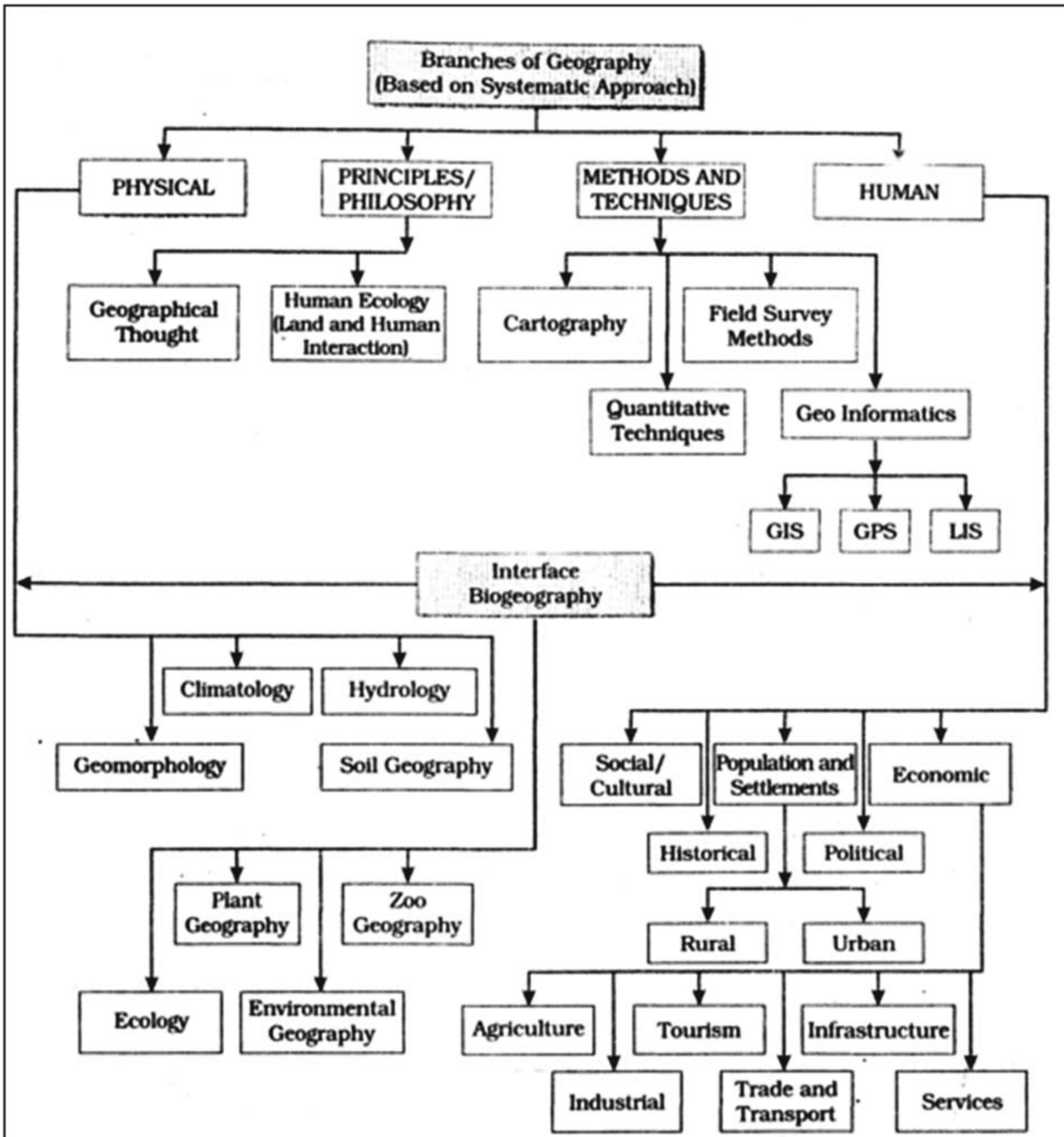
- **Military Geography**

  Practitioners of military geography are most often found within the military but the branch looks not only at the geographic distribution of military facilities and troops but also utilizes geographic tools to develop military solutions.

Political geography investigates all aspects of boundaries, country, state, and nation development, international organizations, diplomacy, internal country subdivisions, voting, and more.

- **Agricultural and Rural Geography**

  Geographers in this branch study agriculture and rural settlement, the distribution of agriculture and the geographic movement and access to agricultural products, and land use in rural areas.



Branches of geography based on systematic approach

- **Transportation Geography**

  Transportation geographers research transportation networks (both private and public) and the use of those networks for moving people and goods.

- **Urban Geography**

  The branch of urban geography investigates the location, structure, development, and growth of cities - from tiny village to huge megapolis.

- **Physical Geography**

  Physical geography is another major branch of geography. It is concerned with the natural features on or near the surface of the earth.

- **Biogeography**

  Biographers study the geographic distribution of plants and animals on the earth in the subject known as biogeography.

- **Geomorphology**

  Geomorphologists study the landforms of the planet, from their development to their disappearance through erosion and other processes.

- **Hazards Geography**

  As with many branches of geography, hazards combines work in physical and human geography. Hazard geographers research extreme events known as hazards or disaster and explore the human interaction and response to these unusual natural or technological events.

- **Mountain Geography**

  Mountain geographers look at the development of mountain systems and at the humans who live in higher altitudes and their adaptations to these environments.

- **Cryosphere Geography**

  Cryosphere geography explores the ice of the earth, especially glaciers and ice sheets. Geographers look at the past distribution of ice on the planet and ice-cause features from glaciers and ice sheets.

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TOPIC 2

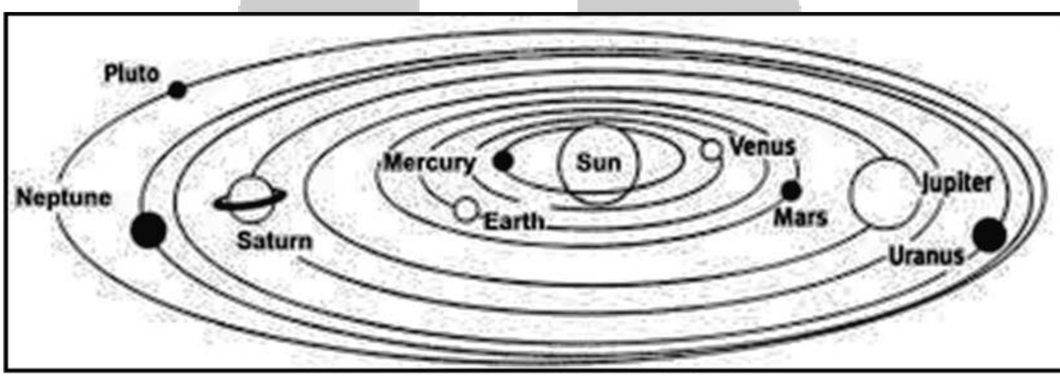
SOLAR SYSTEM

Introduction

Our solar system consists of the sun, planets, dwarf planets, moons, an asteroid belt, comets, meteors, and other objects. The sun is the centre of our solar system; the planets, over 61 moons, the asteroids, comets, meteoroids and other rocks and gas all orbit the Sun.

The **nine planets that orbit the sun are (in order from the Sun): Mercury, Venus, Earth, Mars, Jupiter (the biggest planet in our Solar System), Saturn (with large, orbiting rings), Uranus, Neptune, and Pluto. A belt of asteroids (minor planets made of rock and metal) orbits between Mars and Jupiter**. These objects all orbit the sun in roughly circular orbits that lie in the same plane, (Pluto is an exception; this dwarf planet has an elliptical orbit tilted over 17° from the ecliptic).

The inner planets (those planets that orbit close to the Sun) are quite different from the outer planets (those planets that orbit far from the Sun). The inner planets are: Mercury, Venus, Earth, and Mars. They are relatively small, composed mostly of rock, and have few or no moons. The outer planets include: Jupiter, Saturn, Uranus, Neptune and Pluto. They are mostly huge, mostly gaseous, ringed, and have many moons.



Mercury

Mercury is the planet closest to the Sun in our Solar System. This small, rocky planet has almost no atmosphere. Mercury has a very elliptical orbit and a huge range in temperature. During the long daytime (which lasts 58.65 Earth days or almost an entire Mercurian year, which is 88 days long), the temperature is hotter than an oven; during the long night (the same length), the temperature is colder than a freezer.

Mercury is so close to the Sun that you can only see it near sunrise or set. Mercury is a heavily cratered planet; its surface is similar to the surface of our Moon. Cratering on Mercury triggered volcanic eruptions that filled much of the surrounding area. Mercury does have a magnetic field (probably generated by a partly-liquid iron core).

Size

Mercury is about 3,031 miles (4,878 km) in diameter. It is the smallest planet in our solar system (it used to be considered the second-smallest planet, when Pluto was still considered to be a planet). Mercury is a bit over one third of the diameter of the Earth. Mercury is only slightly larger than the Earth's moon.

Mass and Gravity

Mercury's mass is about 3.3 x 10^{23} kg. This is about 1/20th of the mass of the Earth. The gravity on Mercury is 38% of the gravity on Earth. A 100 pound person would weigh only 38 pounds on Mercury.

Atmosphere

Mercury's thin atmosphere consists of trace amounts of hydrogen and helium. The atmospheric pressure is only about 1 x 10^{-9}millibars; this is a tiny fraction (about 2 trillionths) of the atmospheric pressure on Earth.

Since the atmosphere is so slight, the sky would appear pitch black (except for the sun, stars, and other planets, when visible), even during the day. Also, there is no "greenhouse effect" on Mercury. When the sun sets, the temperature drops very quickly since the atmosphere does not help retain the heat.

Mercury's orbit and distance from the Sun

- Mercury is closest planet to our Sun and the fastest moving planet in our Solar System. Mercury is just over a third as far from the sun as the Earth is; it is 0.387 A.U. from the sun (on average). Mercury's orbit is very eccentric; at aphelion (the point in the orbit farthest from the sun) Mercury is 70 million km from the sun, at perihelion Mercury is 46 million km from the sun.
- There are no seasons on Mercury. Seasons are caused by the tilt of the axis relative to the planet's orbit. Since Mercury's axis is directly perpendicular to its motion (not tilted), it has no seasons.
- If you were on the surface of Mercury, the Sun would look almost three times as big as it does from Earth.

Temperature Range

Mercury has a huge range in temperatures. Its surface ranges in temperature from -270°F to 800°F (-168°C to 427°C). During the very long daytime (88 Earth-days long), the temperatures are very high (the second-highest in the Solar System - only Venus is hotter); during the long night, the thin atmosphere lets the heat dissipate, and the temperature drops quickly.

Moons

Mercury has no moons.

VENUS

Venus is the second planet from the sun in our solar system. **It is the hottest planet in our Solar System**. This planet is covered with fast-moving Sulphuric acid clouds which trap heat from the Sun. Its thick atmosphere is mostly carbon dioxide. Venus has an iron core but only a very weak magnetic field.

This is a planet on which a person would asphyxiate in the poisonous atmosphere, be cooked in the extremely high heat, and be crushed by the enormous atmospheric pressure.

Venus is also known as the "morning star" or the "evening star" since it is visible and quite bright at either dawn or dusk. It is only visible at dawn or dusk since it is closer to the sun than we are. Like the moon, Venus' appearance from Earth changes as it orbits around the Sun. It goes from full to gibbous to crescent to new and back.

Size

Venus is about 7,521 miles (12,104 km) in diameter. This is about 95% of the diameter of the Earth. Venus is the closest to Earth in size and mass of any of the other planets.

Mass and Gravity

Venus mass is about 4.87 x 10^{24} kg. The gravity on Venus is 91% of the gravity on Earth. A 100-pound person would weigh 91 pounds on Venus. The density of Venus is 5,240 kg/m^3,slightly less dense than the Earth and the third densest planet in our Solar System (after the Earth and Mercury).

Length of a day and year on Venus

Venus rotates very slowly. A year on Venus takes 224.7 Earth days. It takes 224.7 Earth days for Venus to orbit the sun once. The same side of Venus always faces Earth when the Earth and Venus are closest together.

Venus orbit and distance from the Sun

Venus is 67,230,000 miles (108,200,000 km) from the sun. Venus has an almost circular orbit. On average, Venus is 0.72 AU (67,230,000 miles = 108,200,000 km) from the sun. Venus rotates in the opposite direction of the Earth (and the other planets, except possibly Uranus). Looking from the north, Venus rotates clockwise, while the other planets rotate counterclockwise. From Venus, the Sun would seem to rise in the west and set in the east (the opposite of Earth).

Temperature on Venus

Venus is the hottest planet in our Solar System. Its cloud cover traps the heat of the sun (the greenhouse effect), giving Venus temperatures up to 480°C. The mean temperature on Venus is 726 K (452°C = 870°F).

Moons

Venus has no moons.

Mars - "The Red Planet"

Surface of Mars is dry, rocky, and mostly covered with iron-rich dust. There are low-lying plains in the northern hemisphere, but the southern hemisphere is dotted with impact craters. The ground is frozen; this permafrost extends for several kilometres.

The north and south poles of Mars are covered by ice caps composed of frozen carbon dioxide and water. Scientists have long thought that there is no liquid water on the surface of Mars now, but recent photos from Mars indicate that there might be some liquid water near the surface.

The surface of Mars shows much evidence of the effects of ancient waterways upon the landscape; there are ancient, dry rivers and lakes complete with huge inflow and outflow channels. These channels were probably caused by catastrophic flooding that quickly eroded the landscape. Scientists think that most of the water on Mars is frozen in the land (as permafrost) and frozen in the polar ice caps.

G. Schiaparelli was an Italian astronomer who first mapped Mars (in 1877) and brought attention to the network of "canali" (Italian term for canals or channels) on Mars. These "canals" were later found to be dry and not to be canals at all. A Martian impact crater (Crater Schiaparelli, 461 km = 277 mi in diameter) and a hemisphere of Mars have been named after Schiaparelli.

Size

Mars is about 4,222 miles (6790 km) in diameter. This is 53% (a little over half) of the diameter of the Earth.

PLANETARY COMPOSITION

Crust and Surface

Mars' surface is composed mostly of iron-rich basaltic rock (an igneous rock). Mars has a thin crust, similar to Earth's.

Mantle

Silicate rock, probably hotter than the Earth's mantle at corresponding depths.

Core

The core is probably iron and sulphides and may have a radius of 800-1,500 miles (1,300-2,400 km). More will be known when data from future Mars missions arrives and is analyzed.

Mass and Gravity

Mars' mass is about 6.42 x 10^23 kg. This is 1/9th of the mass of the Earth. A 100-pound person on Mars would weigh 38 pounds.

Length of a day and year on Mars

Each day on Mars takes 1.03 Earth days (24.6 hours). A year on Mars takes 687 Earth days; it takes this long for Mars to orbit the Sun once.

Mars' Orbit

Mars is 1.524 times farther from the sun than the Earth is. It averages 141.6 million miles (227.9 million km) from the sun. Its orbit is very elliptical; Mars has the highest orbital eccentricity of any planet in our Solar System except Pluto.

Atmosphere

Mars has a very thin atmosphere. It consists of 95% carbon dioxide (CO_2), 3% nitrogen, and 1.6% argon (there is no oxygen). The atmospheric pressure is only a fraction of that on Earth (about 1% of Earth's atmospheric pressure at sea level), and it varies greatly throughout the year.

There are large stores of frozen carbon dioxide at the north and south poles. During the warm season in each hemisphere, the polar cap partly melts, releasing carbon dioxide. During the cold season in each hemisphere, the polar cap partly freezes, capturing atmospheric carbon dioxide.

The atmospheric pressure varies widely from season to season; the global atmospheric pressure on Mars is 25% different (there is less air, mostly carbon dioxide) during the (northern hemisphere) winter than during the summer. This is mostly due to Mars' highly eccentric orbit; Mars is about 20% closer to the Sun during the winter than during the summer. Because of this, the northern polar cap absorbs more carbon dioxide than the southern polar cap absorbs half a Martian year later.

Occasionally, there are clouds in Mars' atmosphere. Most of these clouds are composed of carbon dioxide ice crystals or, less frequently, of frozen water crystals.

There are a lot of fine dust particles suspended in Mars' atmosphere. These particles (which contain a lot of iron oxide) absorb blue light, so the sky appears to have little blue in it and is pink/yellow to butterscotch in colour.

Temperature Range

Mars' surface temperature averages -81 °F (-63 °C). The temperature ranges from a high of 68° F(20° C) to a low of -220° F(-140° C). Mars is much colder than the Earth.

Mars' Moons

Mars has 2 tiny moons, Phobos and Deimos. They were probably asteroids that were pulled into orbit around Mars.

Spacecraft Visits

Mariner 4 was the first spacecraft to visit Mars (in 1965). Two Viking spacecraft landed in 1976. Mars Pathfinder landed on Mars on July 4, 1997, broadcasting photos.

Discovery of Mars

Mars has been known since ancient times.

Mars' name and symbol

Mars was named after the Roman god of war.

JUPITER

Jupiter is the fifth and largest planet in our solar system. This gas giant has a thick atmosphere, 39 known moons, and a dark, barely-visible ring. Its most prominent features are bands across its latitudes and a great red spot (which is a storm).

Jupiter is composed mostly of gas. This enormous planet radiates twice as much heat as it absorbs from the Sun. It also has an extremely strong magnetic field. It is slightly flattened at its poles and it bulges out a bit at the equator.

Size

Jupiter's diameter is 88,700 miles (142,800 km). This is a little more than 11 times the diameter of the Earth. Jupiter is so big that all the other planets in our Solar System could fit inside Jupiter (if it were hollow).

Mass and Gravity

Jupiter's mass is about 1.9 x 10^{27} kg. Although this is 318 times the mass of the Earth, the gravity on Jupiter is only 254% of the gravity on Earth. This is because Jupiter is such a large planet (and the gravitational force a planet exerts upon an object at the planet's surface is proportional to its mass and to the inverse of its radius squared). A 100-pound person would weigh 254 pounds on Jupiter.

Length of a day and year on Jupiter

It takes Jupiter 9.8 Earth hours to revolve around its axis (this is a Jovian day). It takes 11.86 Earth years for Jupiter to orbit the sun once (this is a Jovian year).

Jupiter is made up of gases and liquids, so as it rotates, its parts do not rotate at exactly the same velocity. It rotates very rapidly, and this spinning action gives Jupiter a large equatorial bulge; it looks like a slightly-flattened sphere (it is oblate)

Jupiter's Orbit

Jupiter is 5.2 times farther from than the Sun than the Earth. On average, it is 480,000,000 miles (778,330,000 km) from the sun. At aphelion (the place in its orbit where Jupiter is farthest from the Sun), Jupiter is 815,700,000 km from the Sun. At perihelion (the place in its orbit where Jupiter is closest to the Sun), Jupiter is 749,900,000 km from the Sun.

Jupiter has no seasons. Seasons are caused by a tilted axis, and Jupiter's axis is only tilted 3 degrees (not enough to cause seasons).

Jupiter's Moons

Jupiter has four large moons and dozens of smaller ones (there are 39 moons known so far). More moons are being found all the time.

Galileo first discovered the four largest moons of Jupiter, Io (which is volcanically active), Europa, Ganymede (the largest of Jupiter's moons, pictured at the left), and Callisto in 1610; these moons are known as the Galilean moons. Ganymede is the largest moon in the Solar System.

Rings of Jupiter

Jupiter has faint, dark rings composed of tiny rock fragments and dust. These rings were discovered by NASA's Voyager 1 in 1980. The rings were investigated further when Voyager 2 flew by Jupiter. The rings have an albedo of 0.05; they do not reflect very much of the sunlight that they receive.

Temperature Range

The cloud-tops average 120 K = -153°C = -244°F.

Discovery of Jupiter

Jupiter has been well-known since ancient times. It is the third-brightest object in the night sky (after the moon and Venus).

Comet SL-9 hits Jupiter

Shoemaker-Levy 9 (SL-9) was a short-period comet that was discovered by Eugene and Carolyn Shoemaker and David H. Levy. As the comet passed close by Jupiter, Jupiter's gravitational forces broke the comet apart. Fragments of the comet collided with Jupiter for six days during July, 1994, causing huge fireballs in Jupiter's atmosphere that were visible from Earth.

Spacecraft visits

Jupiter was first visited by NASA's Pioneer 10, which flew by Jupiter in 1973. Later fly-by visits included: Pioneer 11, Voyager 1, Voyager 2, Ulysses, and Galileo.

Jupiter's name and symbol

Jupiter was named after the Roman primary god, Jupiter.

Saturn

Saturn is the sixth planet from the sun in our solar system. It is the second-largest planet in our solar system (Jupiter is the largest). It has beautiful rings that are made mostly of ice chunks (and some rock) that range in size from the size of a fingernail to the size of a car. Saturn is made mostly of hydrogen and helium gas. Saturn is visible without using a telescope, but a low-power telescope is needed to see its rings.

Size and Shape

Saturn is about 74,898 miles (120,536 km) in diameter (at the equator at the cloud tops). This is about 9.4 times the diameter of the Earth. 764 Earths could fit inside a hollowed-out Saturn.

Saturn is the most oblate (flattened) planet in our Solar System. It has a equatorial diameter of 74,898 miles (120,536 km) (at the cloud tops) and a polar diameter of 67,560 miles (108,728 km). There is a difference of about 10%. Saturn's flattened shape is probably caused by its fast rotation and its gaseous composition.

Rings

Saturn's beautiful rings are only visible from Earth using a telescope. They were first observed by Galileo in the 17th century. Saturn's bright rings are made of ice chunks (and some rocks) that range in size from the size of a fingernail to the size of a car. Although the rings are extremely wide (over 1 million km in diameter), they are very thin (about 0.6 miles = 1 km thick).

Mass, Gravity and Density

Saturn's mass is about 5.69 x 10^{26} kg. Although this is 95 times the mass of the Earth, the gravity on Saturn is only 1.08 times the gravity on Earth. This is because Saturn is such a large planet (and the gravitational force a planet exerts upon an object at the planet's surface is proportional to its mass and to the inverse of its radius squared). A 100 pound person would only weigh 108 pounds on Saturn.

Saturn is the only planet in our Solar System that is less dense than water. Saturn would float if there were a body of water large enough.

Length of a day and year on Saturn

Each day on Saturn takes 10.2 Earth hours. A year on Saturn takes 29.46 Earth years; it takes 29.46 Earth years for Saturn to orbit the sun once.

Orbit and distance from the Sun

Saturn is 9.539 AU, on average, from the sun, about 9 and a half times as far from the Sun as the Earth is. At aphelion (the place in its orbit where Saturn is farthest from the Sun), Saturn is 1,503,000,000 km from the Sun. At perihelion (the place in its orbit where Saturn is closest to the Sun), Saturn is 1,348,000,000 km from the Sun.

Temperature on Saturn

The mean temperature on Saturn (at the cloud tops) is 88 K (-185° C; -290° F).

Moons of Saturn

Saturn has dozens of moons (33 discovered as of August, 2004). It has 18 named moons including Titan (the largest), Rhea, Iapetus, Dione, Tethys, Enceladus, Mimas, Hyperion, Phoebe, Janus, Epimetheus, Pandora, Prometheus, Helene, Telesto, Atlas, Calypso, and Pan (the smallest named moon of Saturn). At least a dozen others have been noted (but not named yet).

Spacecraft visits

Saturn has been visited by Pioneer 11 (in 1979) and by Voyager 1 and Voyager 2. Cassini, a spacecraft named for the divisions in Saturn's rings, visited it in 2004.

NEPTUNE

Neptune is the eighth planet from the sun in our solar system. This giant, frigid planet has a hazy atmosphere and strong winds. This gas giant is orbited by eight moons and narrow, faint rings arranged in clumps. Neptune's blue colour is caused by the methane (CH_4) in its atmosphere; this molecule absorbs red light.

Neptune cannot be seen using the eyes alone. Neptune was the first planet whose existence was predicted mathematically (the planet Uranus's orbit was perturbed by an unknown object which turned out to be another gas giant, Neptune).

Size

Neptune is about 30,775 miles (49,528 km) in diameter. This is 3.88 times the diameter of the Earth. If Neptune were hollow, it could hold almost 60 Earths. Neptune is the fourth largest planet in our Solar System (after Jupiter, Saturn, and Uranus).

Mass and Gravity

Neptune's mass is about 1.02 x 10^{26} kg. This is over 17 times the mass of the Earth, but the gravity on Neptune is only 1.19 times of the gravity on Earth. This is because it is such a large planet. A 100-pound person would weigh 119 pounds on Neptune.

Length of a day and year on Neptune

Each day on Neptune takes 19.1 Earth hours. A year on Neptune takes 164.8 Earth years; it takes almost 165 Earth years for Neptune to orbit the sun once. Since Neptune was discovered in 1846, it has not yet completed a single revolution around the sun.

Neptune's orbit and distance from the Sun

Neptune is about 30 times farther from the sun than the Earth is; it averages 30.06 A.U. from the sun. Occasionally, Neptune's orbit is actually outside that of Pluto; this is because of Pluto's highly eccentric (non-circular) orbit. During this time (20 years out of every 248 Earth years), Neptune is actually the farthest planet from the Sun (and not Pluto). From January 21, 1979 until February 11, 1999, Pluto was inside the orbit of Neptune. Now and until September 2226, Pluto is outside the orbit of Neptune.

At aphelion (the point in Neptune's orbit farthest from the sun) Neptune is 4,546,000,000 km from the sun, at perihelion (the point in Neptune's orbit closest from the sun) Neptune is 4,456,000,000 km from the sun.

Neptune's rotational axis is tilted 30 degrees to the plane of its orbit around the Sun (this is few degrees more than the Earth). This gives Neptune seasons. Each season lasts 40 years; the poles are in constant darkness or sunlight for 40 years at a time.

Temperature

The mean temperature is 48 K.

Discovery of Neptune

Neptune's existence was predicted in 1846, after calculations showed perturbations in the orbit of Uranus. The calculations were done independently by both J.C. Adams and Le Verrier. Neptune was then observed by J.G. Galle and d'Arrest on September 23, 1846.

Spacecraft visits

Neptune was visited by NASA's Voyager 2 in August, 1989. Before this visit, virtually nothing was known about Neptune.

Pluto

Pluto is a dwarf planet (or plutoid) that usually orbits past the orbit of Neptune. It was classified as a dwarf planet in 2006; before that it was considered to be a planet, the smallest planet in our solar system. There are many other dwarf planets in our Solar System. Pluto is smaller than a lot of the other planets' moons, including our moon. We only have blurry pictures of its surface; even the Hubble Space Telescope orbiting the Earth can only get grainy photos because Pluto is so far from us. In 2015, a spacecraft called New Horizons (launched by NASA in 2006) visited Pluto.

Size

Pluto is about 1,413 miles (2274 km) in diameter. This is about 1/5 the diameter of the Earth. Pluto is smaller than the 8 planets in our Solar System.

Mass and Gravity

Pluto's mass is about 1.29 x 10^{22} kg. This is about 1/500th of the mass of the Earth. The gravity on Pluto is 8% of the gravity on Earth. Pluto is the least massive planet in our Solar System (and is now classified as a dwarf planet). A 100 pound person on Pluto would weigh only 8 pounds.

Length of a day and year on Pluto

Each day on Pluto takes 6.39 Earth days. Each year on Pluto takes 247.7 Earth years (that is, it takes 247.7 Earth years for Pluto to orbit the Sun once).

Temperature on Pluto

Pluto is very, very cold. Its temperature ranges from -396°F to -378°F (-238°C to -228°C, or 35 K to 45 K). The average temperature is -393°F (-236°C = 37 K).

Planetary Composition

Pluto's composition is unknown. It is probably made up of about 70% rock and 30% water. This is determined from density calculations; Pluto's density is about 2,000 kg/m^3. There may be methane ice together with frozen nitrogen and carbon dioxide on the cold, rocky surface.

Atmosphere

Not much is known about Pluto's atmosphere. It is probably mostly nitrogen with a little carbon monoxide and methane - definitely not breatheable by humans. The atmospheric pressure is probably very low. The atmosphere forms when Pluto is closest to the Sun and the frozen methane is vapourized by the solar heat. When it is farther from the Sun, the methane freezes again. From Pluto, the sky would appear black, even when the Sun (the size of a star) is up.

Pluto's Moons

Pluto has one large moon, named Charon; two minuscule moons were discovered in 2005. Although Charon is small, about 1,172 km (728 miles) in diameter, it is about half of the size of Pluto itself. Charon orbits about 19,640 km from Pluto on average. It may be covered by water ice and probably has no atmosphere. Charon is in a synchronous orbit around Pluto.

Universe

Our universe is both ancient and vast, and expanding out farther and faster every day. This accelerating universe, the dark energy that seems to be behind it, and other puzzles like the exact nature of the Big Bang and the early evolution of the universe are among the great puzzles of cosmology.

There was a time when scientists thought Earth was at the centre of the universe. As late as the 1920s, we did not realize that our galaxy was just one of many in a vast universe. Only later did we recognize that the other galaxies were running away from us — in every direction — at ever greater speeds. Likewise in recent decades, our understanding of the universe has accelerated.

Theories Regarding the Origin of Universe

- Big-Bang Theory: By E George Lamantor
- Steady State Theory: By Thomas Gold and Herman Bondy
- Pulsating Universe Theory: By Dr. Allen Sundes

Big Bang Theory

- This is the most acclaimed theory regarding the origin of the universe. It was proposed by a Belgian Astronomer and Clergy, E George Lamantor in 1960-70 A.D. According to him, 15 billion years ago there was a big heavenly body, made up of heavy matters. Due to sudden explosion (Big Bang) of this heavenly body, normal matters came out of it and many celestial bodies were created as a result of aggregation of these normal matters.
- Gradually their size increased due to continuous accumulation of normal matter around them. In this way, galaxies were created. Stars were formed due to re-explosion of these galaxies. In course of time, the planets were also formed in the same process. The ever-increasing distance between the galaxies proves this phenomenon. NASA has confirmed this in a project called MAP (Microwave Anisotrophy Probe) in 2001.

Galaxies And Stars

- There are about 100 billion galaxies in the universe. A Galaxy is a large constellation of stars in which there is a central bulge and three rotating arms. These rotating arms are composed of several stars. The bulge is the centre of the galaxy, where there is the highest concentration of the stars. Every galaxy is composed of about 100 billion stars. Limon Alfa Blobs, in the shape of Amoeba, is composed of galaxies having width of 20 crore light years, and gases.
- Galaxies of this Blobs are four-times closer to each-other than that of galaxies present in the Universe. Andromeda is the closest to our galaxy (Milky Way) which is 2.2 million light years away from us. Our own galaxy is known as **'Mandakini'** which has Spiral shape. A group of stars known **as 'Milky Way'** seen in the night, is a part of our galaxy.
- Orian Nebula is the brightest and the coldest group of stars of our galaxy. The diameter of 'Mandakini' is about 105 light years. **The Sun is a star of our galaxy** and takes more than 200 million years to complete one revolution around the centre of the galaxy. Planemus, outside the solar system, is a group of twin bodies looking same.
- Sirius or DogStar is 9 light years away from the earth and has a mass two times that of the Sun. It is 20 times brighter than the Sun and is the brightest star seen in the night. Proxima Centaury, a star, is the nearest to the Sun, about. 4.3 light years away from the Sun. Galelio, in 1609A.D., studied the sky in night using Telescope for the first time. He discovered such stars which cannot be seen through naked eyes.
- On the occasion of the completion of four hundred years of Galelio's discovery, International Astronomical Union decided to celebrate the year 2009 as the year of International Astronomy. Asias largest telescope is being installed in Devasthal of Uttarakhand. It is proposed to set up the world largest telescope in Ladakh (Jammu and kashmir). This telescope will help to study the climate change.

Life Cycle Of Stars

- Rotation of the galaxy causes the gaseous clouds present in the universe to become compact and due to the gravitation the process of nuclear fusion starts at the centre of this gaseous mass, converting hydrogen into helium. This process liberates an enormous amount of energy in the form of heat and light. At this stage the gaseous mass becomes a star.
- As the time passes, all the hydrogen at the centre gets converted into helium, and the centre starts to contract under its own gravity. But, the outer layer still contains some hydrogen which keeps on changing into helium through nuclear fusion.
- Due to imbalance in the gravitational pull of the centre and enormous energy produced in the outer layer, the star expands to a large size. The **temperature of the star at this stage also falls down, so it appears red**. This is the Red Giant Star.
- After the Red Giant phase the future of the star depends upon the initial mass of the star. Now the helium starts converting into carbon and carbon into heavy metal like iron in the core. This results in a massive explosion in the star which is known as supernova.
- If the initial mass of the star is less than 1.4 Ms (Ms= Mass of the Sun), then it ends its life as a white dwarf star, which is also known as a Fossil star. White dwarf ultimately turns into a Black dwarf. The limit 1.4 Ms of solar mass has come to be known a 'Chandrasekhar Limit'. Unlike this, if the mass of the star is much more than the mass of the sun then it becomes a Neutron Star.
- A rotating Neutron star is known as Pulsar. A Neutron Star remains contracting and, thus, mass in a large quantity, concentrates on one point. Such body with high density is called Black Hole. It does not allow anything to escape, including the light due to which it cannot be seen. It is John Wheeler who propounded the concept of Black Hole. Raug black hole is a group of two or more black holes. Quasars is an astronomical body which emits energy in very large quantity.

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TOPIC 3

LATITUDES, LONGITUDES AND MOTIONS OF EARTH

THE SHAPE OF EARTH

There has been so much research done on earth science that its various dimensions have been accurately found. It has an equatorial circumference of 24,897 miles and its polar circumference is less by 83 miles. Its equatorial diameter is 7,926 miles and its polar diameter is shorter by 26 miles. This simply shows that the earth is not a perfect sphere. It is a little flattened at both ends like an orange. It can, in fact, be called a geoid ('earth-shaped'). The spherical shape of the earth is also masked by the intervening high-lands and oceans on its surface.

Evidence of the Earth's Sphericity

There are many ways to prove that the earth is spherical. The following are some of them.

- **Circum-navigation of the earth**

  The first voyage around the world by Ferdinand Magellan and his crew, from 1519 to 1522 proved beyond doubt that the earth is spherical. No traveller going round the world by land or sea has ever encountered an abrupt edge, over which he would fall. Modern air routes and ocean navigation are based on the assumption that the earth is round.

- **The circular horizon**

  The distant horizon viewed from the deck of a ship at sea, or from a cliff on land is always and everywhere circular in shape. This circular horizon widens with increasing altitude and could only be seen on a spherical body.

- **Sunrise and sunset**

  The sun rises and sets at different times in different places. As the earth rotates from west to east, places in the east see the sun earlier than those in the west. If the earth were flat, the whole world would have sunrise and sunset at the same time. But we know this is not.

- **The lunar eclipse**

  The shadow cast by the earth on the moon during the lunar eclipse is always circular. It takes the outline of an arc of a circle. Only a sphere can cast such a circular shadow.

- **Planetary bodies are spherical**

  All observations from telescopes reveal that the planetary bodies, the Sun, Moon, satellites and stars have circular outlines from whichever angle you see them. They are strictly spheres. Earth, by analogy, cannot be the only exception.

- **Driving poles on level ground on a curved earth**

  Engineers when driving poles of equal length at regular intervals on the ground have found that they do not give a perfect horizontal level. The centre pole normally projects slightly above the poles at either end because of the curvature of the earth.

- **Aerial photographs**

  Pictures taken from high altitudes by rockets and satellites show clearly the curved edge of the earth. This is perhaps the most convincing and the most up-to-date proof of the earth's sphericity.

The Earth's Movement

Man is always conscious of the **'apparent movement of the sun'** and little realizes that the earth on which he stands is constantly in motion. When the sun disappears, he says that the sun sets and when it emerges, he says that the sun rises. He is not the least aware that the sun, in fact, does not rise or set, it is we who rise and we who set. The earth moves in space in two distinct ways: it rotates on its own axis from west to east once in every 24 hours, causing day and night; it also round the sun in an orbit once in every 365 days. causing the seasons and the year.

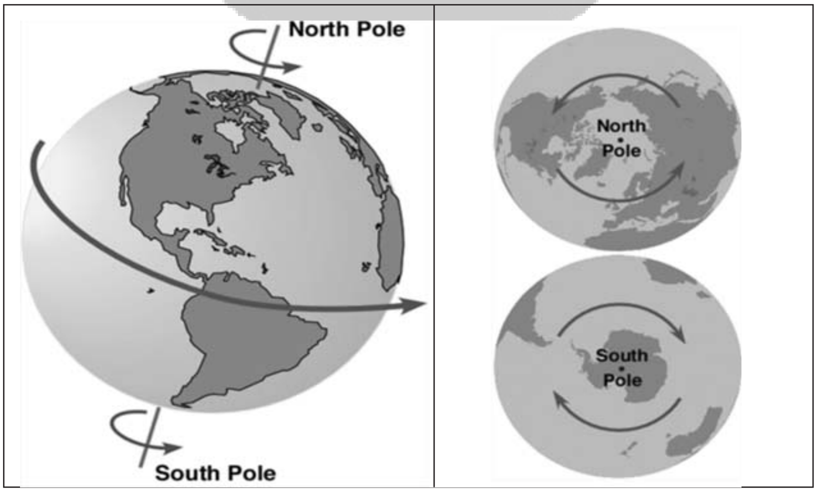
Day and Night

When the earth rotates on its own axis, only one portion of the earth's surface comes into the rays of the sun and experiences daylight. The other portion which is away from the sun's rays will be in darkness. As the earth rotates from west to east, every part of the earth's surface will be brought under the sun at some time or other.

A part of the earth's surface that emerges from darkness into the sun's rays experiences sunrise. Later, when it is gradually obscured from the sun's beams it experiences sunset. The sun is, in fact, stationary and it is the earth which rotates. The illusion is exactly the same as when we travel in a fast-moving train. The trees and houses around us appear to move and we feel that the train is stationary.

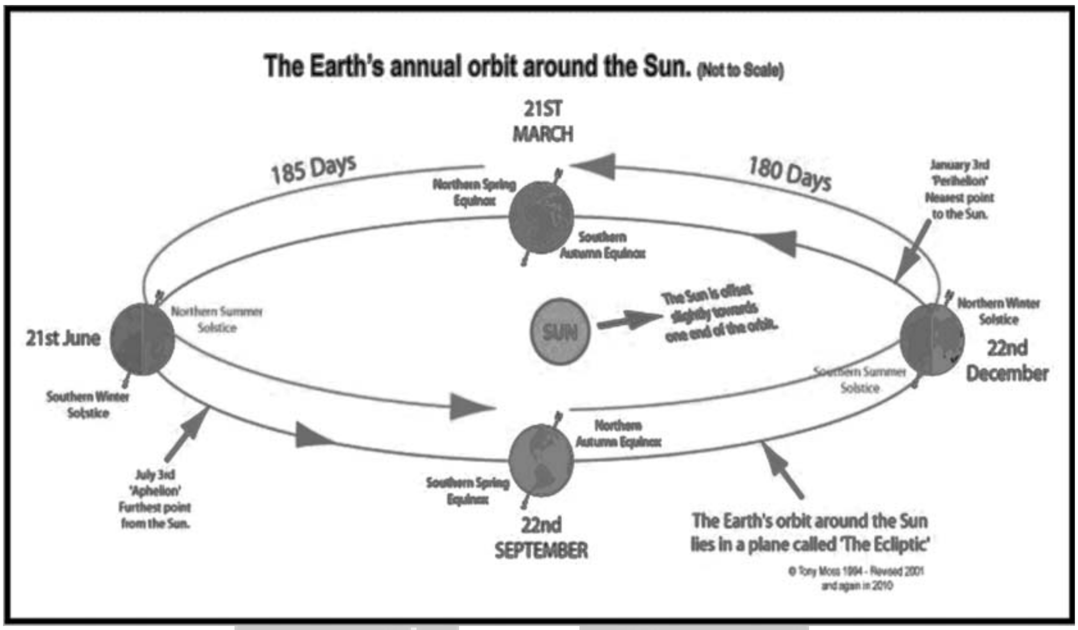
Earth Rotation and Revolution

- The term Earth rotation refers to the spinning of our planet on its axis. Because of rotation, the Earth's surface moves at the equator at a speed of about 467 m per second or slightly over 1675 km per hour. If you could look down at the Earth's North Pole from space you would notice that the direction of rotation is counter-clockwise.
- **T**he opposite is true if the Earth is viewed from the South Pole. One rotation takes exactly twenty-four hours and is called a mean solar day. The Earth's rotation is responsible for the daily cycles of day and night.

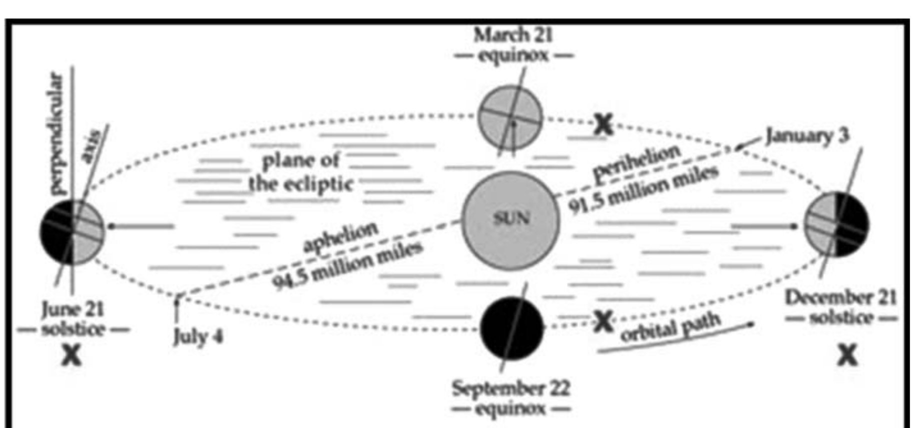


<u>The movement of the Earth about its axis is known as rotation. The direction of this movement varies with the viewer's position. From the North Pole the rotation appears to move in a counter-clockwise fashion. Looking down at the South Pole the Earth's rotation appears clockwise.</u>

- At any one moment in time, one half of the Earth is in sunlight, while the other half is in darkness. The edge dividing the daylight from night is called the circle of illumination. The Earth's rotation also creates the apparent movement of the Sun across the horizon.
- The orbit of the Earth around the Sun is called an Earth's revolution. This celestial motion takes 365.26 days to complete one cycle. Further, the Earth's orbit around the Sun is not circular, but oval or elliptical (as shown in the figure below).



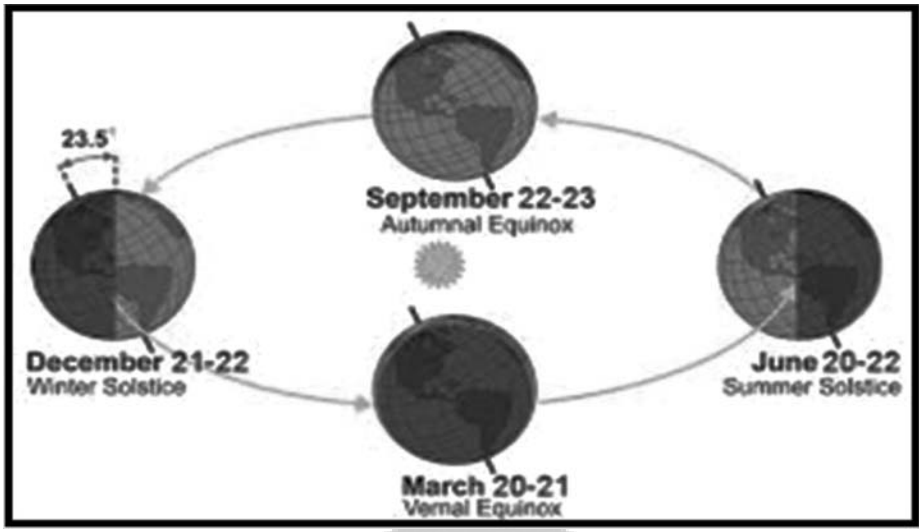
- An elliptical orbit causes the Earth's distance from the Sun to vary over a year. Yet, this phenomenon is not responsible for the Earth's seasons! This variation in the distance from the Sun causes the amount of solar radiation received by the Earth to annually vary by about 6%.
- The figure illustrates the positions in the Earth's revolution where it is closest and farthest from the Sun. On January 3, perihelion, the Earth is closest to the Sun (147.3 million km). The Earth is farthest from the Sun on July 4, or aphelion (152.1 million km). The average distance of the Earth from the Sun over a one-year period is about 149.6 million km.



Position of the equinoxes, solstices, aphelion, and perihelion relative to the Earth's orbit around the Sun. The equinoxes and solstices should be 90^0 apart in the ecliptic plane.

Tilt of the Earth's Axis

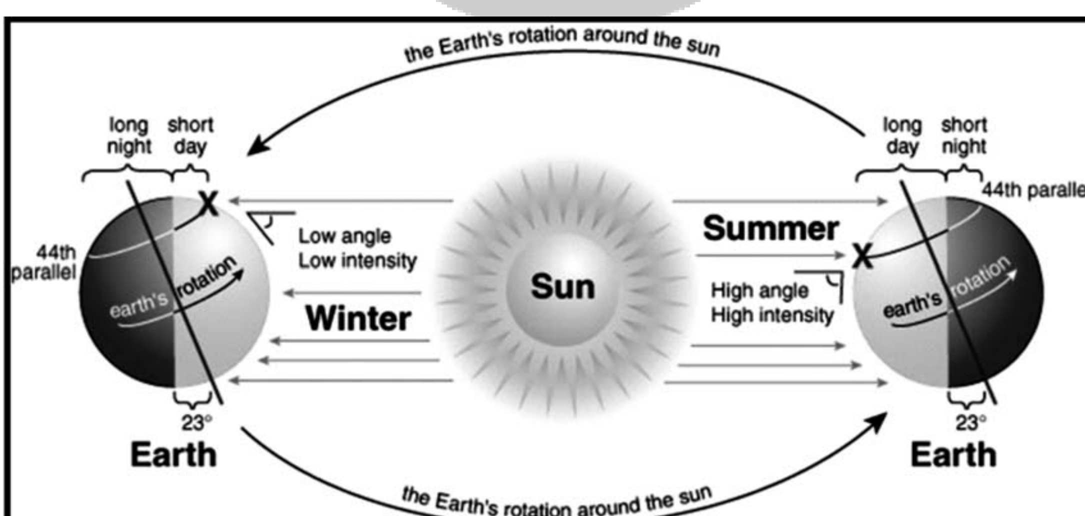
The ecliptic plane can be defined as a two-dimensional flat surface that geometrically intersects the Earth's orbital path around the Sun.



On this plane, the Earth's axis is not at right angles to this surface, but inclined at an angle of about 23.5° from the perpendicular. Figure shows a side view of the Earth in its orbit about the Sun on four important dates: June solstice, September equinox, December solstice, and March equinox.

Note that the angle of the Earth's axis in relation to the ecliptic plane and the North Star on these four dates remains unchanged.

- Yet, the relative position of the Earth's axis to the Sun does change during this cycle. This circumstance is responsible for the annual changes in the height of the Sun above the horizon. It also causes the seasons, by controlling the intensity and duration of sunlight received by locations on the Earth.
- In this view, we can see how the circle of illumination changes its position on the Earth's surface. During the two equinoxes, the circle of illumination cuts through the North Pole and the South Pole.
- On the June solstice, the circle of illumination is tangent to the Arctic Circle (66.5° N) and the region above this latitude receives 24 hours of daylight. The Arctic Circle is in 24 hours of darkness during the December solstice.



- On June 21 or 22 the Earth is positioned in its orbit so that the North Pole is leaning 23.5° toward the Sun. During the June solstice (also called the summer solstice in the Northern Hemisphere), all locations north of the equator have day lengths greater than twelve hours, while all locations south of the equator have day lengths less than twelve hours (see table given below).

- On December 21 or 22 the Earth is positioned so that the South Pole is leaning 23.5 degrees toward the Sun. During the December solstice (also called the winter solstice in the Northern Hemisphere), all locations north of the equator have day lengths less than twelve hours, while all locations south of the equator have day lengths exceeding twelve hours.
- On September 22 or 23, also called the autumnal equinox in the Northern Hemisphere, neither pole is tilted toward or away from the Sun. In the Northern Hemisphere, March 20 or 21 marks the arrival of the vernal equinox or spring when once again the poles are not tilted toward or away from the Sun. Day lengths on both of these days, regardless of latitude, are exactly 12 hours.

Location's Latitude	March Equinox March 20/21	June Solstice June 21/22	September Equinox September 22/23	December Solstice December 21/22
90 N	0 degrees	23.5 degrees	0 degrees	- 23.5 degrees
70 N	20 degrees	43.5 degrees	20 degrees	-3.5 degrees
66.5 N	23.5 degrees	47 degrees	23.5 degrees	0 degrees
60 N	30 degrees	53.5 degrees	30 degrees	6.5 degrees
50 N	40 degrees	63.5 degrees	40 degrees	16.5 degrees
23.5 N	66.5 degrees	90 degrees	66.5 degrees	43 degrees
0 degrees	90 degrees	66.5 degrees	90 degrees	66.5 degrees
23.5 S	66.5 degrees	43 degrees	66.5 degrees	90 degrees
50 S	40 degrees	16.5 degrees	40 degrees	63.5 degrees
60 S	30 degrees	6.5 degrees	30 degrees	53.5 degrees
66.5 S	23.5 degrees	0 degrees	23.5 degrees	47 degrees
70 S	20 degrees	-3.5 degrees	20 degrees	43.5 degrees
90 S	0 degrees	- 23.5 degrees	0 degrees	23.5 degrees

Location Of Places On Globe

The earth is a sphere and has no edges from which you can measure your distance. It has, however, two fixed points - **the North Pole and the South Pole** - which serve as basic points of reference. One set of lines are drawn in between the two poles in an east-west direction. These are parallel to the equator. That is why they are called **Parallel of Latitude.**

The other set of lines are drawn joining the North and the South Poles. They are semi-circles. They are called **Meridian of Latitudes**. However, on some maps, they appear as east-west and north-south lines. With the help of these lines we can determine, the position of any place on the, surface of the earth.

Latitude

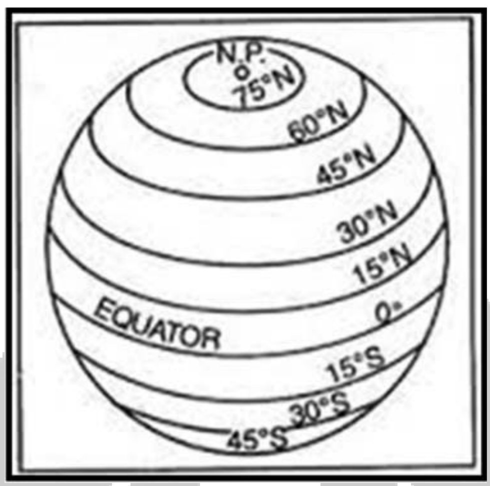
You know that the axis of the earth which joins the North Pole and the South Pole is an imaginary line.

Another imaginary line is the **Zero degrees is the equator** which is drawn in such a way that at all points it lies exactly halfway between the North Pole and the South Pole. It thus divides the earth into two equal parts i.e. the Northern and the Southern Hemispheres 90° north is the North Pole and 90° south is the South Pole. As such, all points north of equator are called as 'north latitudes'. Similarly all points in south are called as 'south latitude'.

When looking at a map, **latitude lines run horizontally.** Latitude lines are also known as parallels since they are parallel and are an equal distant from each other. Each degree of latitude is approximately 69 miles (111 km) apart; **there is a variation due to the fact that the earth is not a perfect sphere but an oblate ellipsoid (slightly egg-shaped).** To remember latitude, imagine them as the horizontal rungs of a ladder ("ladder-tude"). Degrees latitude are numbered from 0° to 90° north and south.

Important Parallel Of Latitudes

- The equator is the largest possible circle which can be drawn around the earth.
- The Tropic of Cancer is an important parallel of latitude in the Northern Hemisphere. It is an angular distance of $23^{1/2}$ (23^0 30'N) from the equator. If you see the map of India, you will find that the Tropic of Cancer runs in an east -west direction almost midway through our country. The Tropic of Capricorn (23^0 30'S) is another parallel similar to the Tropic of Cancer but is in the Southern Hemisphere.

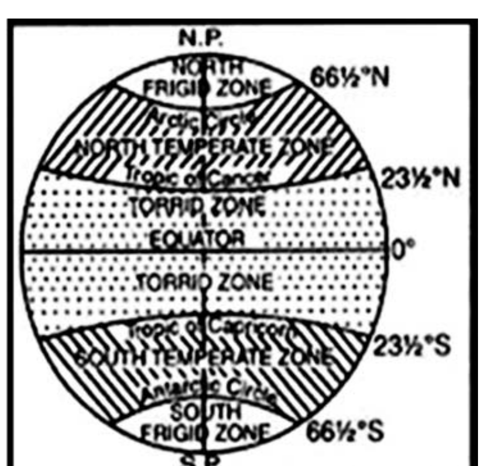


- The Arctic Circle lies at a distance $66^{1/2}$ (66^0 30'N) north of the equator.
- The Antarctic Circle (66^0 30'S) is similar to the Arctic Circle but lies in the Southern Hemisphere.

Heat Zones of India

The midday 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 Zones.**

The midday 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. Beyond the Arctic and the Antarctic Circles, the sun does not rise much above the horizon.



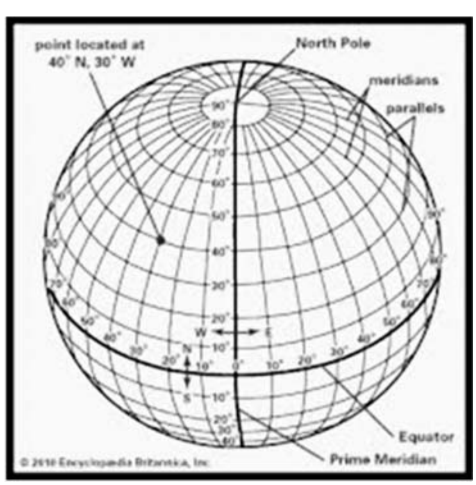
As such the areas bounded by the Tropic of Cancer and the Arctic Circle in the Northern Hemisphere, and the Tropic of Capricorn and the Antarctic Circle in the Southern Hemisphere, have moderate temperature. These are therefore, called Temperate Zones.

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 the sun does not rise much above the horizon. Therefore its rays are always very slanting. These are, therefore, called Frigid Zones.

Longitude

To fix the position of a place, it is necessary to know something more than the latitude of that place. You can see, for example, that Hyderabad (in Pakistan) and Allahabad (in India) are situated on the same latitude (i.e., 25^0 2S'N).). Now, in order to locate them precisely we must find out how far east or west these places are from a given line of reference running from the North Pole to the South Pole.

These lines of reference are called meridians of longitude, and the distances between them are measured in 'degrees of longitude'. Each degree is further divided into minutes and seconds. They are semi-circles and the distance between them decreases steadily polewards, until it becomes zero at the poles, where all the meridians meet. Unlike parallels of latitude, all meridians are of equal length. Thus, it was difficult to number the meridians.



Hence all countries decided that the count should begin from the meridian which passed through Greenwich, where the British Royal Observatory was located. This meridian was called the **Prime Meridian.** Its value is

0^0 longitude and from it we count 180^0 eastward as well as 180^0 westward. Therefore the longitude of a place is followed by the letter E or W.

Thus, if we have to state the longitude of Jabalpur which is situated 80^0 east of Greenwich, we shall say that its longitude is 80^0 E. It is, however, interesting to note that 180^0 East and 180^0 West meridians are the same line.

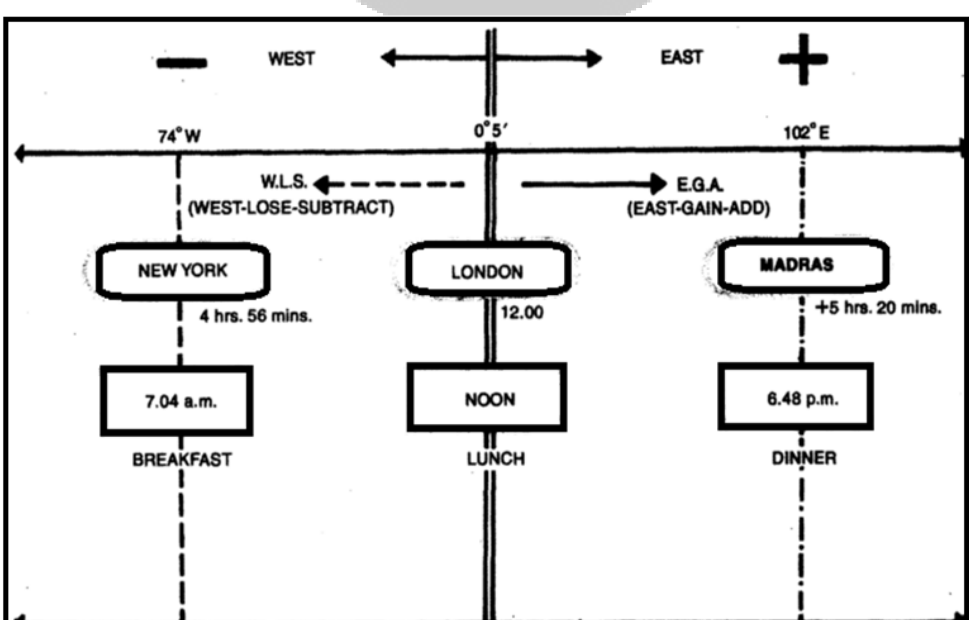
The best means of measuring time is by the movement of the earth, the moon and the planets.

Longitude And Time

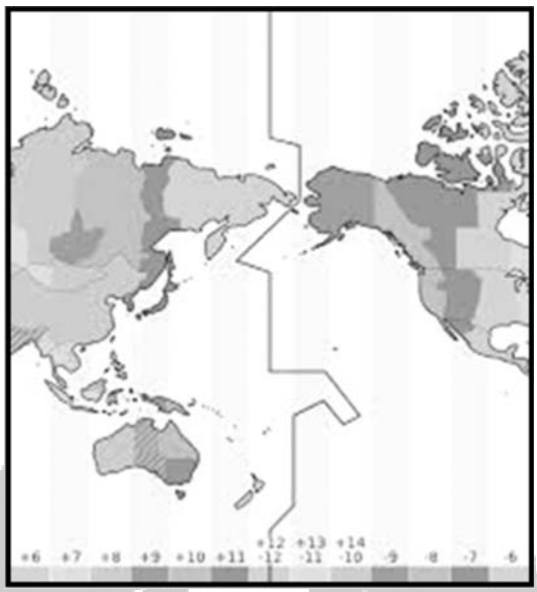
- The sun regularly rises and sets every day and naturally it is the best time-keeper throughout the world.
- 'Local' time can be reckoned by the shadow cast by the sun, which is shortest at noon and longest at sunrise and, sunset.
- When the Prime Meridian of Greenwich has, the sun at the highest point in the sky, all the places along this meridian will have, midday 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 follows. 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 15^0 east of Greenwich will be 15 X 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 a.m. Similarly, at 180^0 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 midday. 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.

Standard Time

- The local time of places which are on different meridians are bound to differ. This will create problems for the people. 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 $82^{1/2}$E (82^0 30'E) 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).
- 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 15^0 of longitudes.



International Dateline

- The International Date Line sits on the 180º line of longitude in the middle of the Pacific Ocean, and is the imaginary line that separates two consecutive calendar days.
- It is not a perfectly straight line and has been moved slightly over the years to accommodate needs (or requests) of varied countries in the Pacific Ocean. Note how it bends to include all of Kiribati, Samoa, Tonga and Tokelau in the Eastern Hemisphere.
- Immediately to the left of the International Date Line, the date is always one day ahead of the date (or day) immediately to the right of the International Date Line in the Western Hemisphere.
- So, travel east across the International Date Line results in a day, or 24 hours, being subtracted. Travel west across the International Date Line results in a day being added.

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