IAS BABA

# PEP – 2024

## PRELIMS EXCLUSIVE PROGRAMME

ONE STOP DESTINATION FOR PRELIMS PREPARATION

## GEOGRAPHY

## HANDOUTS

Notes

# Contents

## Geography

Notes

***TOPICS:*** *General Geography- Universe & Solar system, Latitude and Longitude, Motions of the Earth - Rotation, Revolution and their effects, Inclination of the Earth's Axis and its effects, Time Zones, Local and Standard Time and the International Date Line, Calendar, Eclipses - Solar, Lunar*
*Climatology- Layers of Atmosphere, Temperature Inversion*

## PREVIOUS YEARS QUESTIONS

**Q.1) Variations in the length of daytime and night time from season to season are due to**

a) the earth's rotation on its axis
b) the earth's revolution around the sun in an elliptical manner
c) latitudinal position of the place
d) revolution of the earth on a tilted axis

**Q.2) On 21st June, the Sun**

a) does not set below the horizon at the Arctic Circle
b) does not set below the horizon at Antarctic Circle
c) shines vertically overhead at noon on the Equator
d) shines vertically overhead at the Tropic of Capricorn

**Q.3) In the northern hemisphere, the longest day of the year normally occurs in the:**

a) First half of the month of June
b) Second half of the month of June
c) First half of the month of July
d) Second half of the month of July

Notes

## Universe

The most popular argument regarding the origin of the universe is the Big Bang Theory also called **expanding universe hypothesis.**

**The Big Bang Theory considers the following stages in the development of the universe.**

- In the beginning, all matter forming the universe existed in one place in the form of a "tiny ball" (singular atom) with an unimaginably small volume, infinite temperature and infinite density.
- At the Big Bang the "tiny ball" exploded violently. This led to a huge expansion. It is now generally accepted that the event of big bang took place 13.7 billion years before the present. The expansion continues even to the present day.
- As it grew, some energy was converted into matter. There was particularly rapid expansion within fractions of a second after the bang.
- In the first moments after the Big Bang, the universe was extremely hot and dense. As the universe cooled, conditions became just right to give rise to the building blocks of matter, like the quarks and electrons of which we are all made.
    - Here, the Inflation Theory proposes a period of extremely rapid (exponential) expansion of the universe during its first few moments.
- Within 300,000 years from the Big Bang, temperature dropped to 4,500K (Kelvin) and gave **rise to atomic matter.** These were mainly helium and hydrogen, which are still by far the most abundant elements in the universe. The universe became transparent.
- The expansion of universe means increase in space between the galaxies.

In 1929, American astronomer Edwin Hubble discovered that the distances to far-away galaxies were proportional to their redshifts. Hubble's observation implied that distant galaxies were moving away from us, as the furthest galaxies had the fastest apparent velocities. Hubble reasoned that if the galaxies are moving away from us, then at some time in the past, they must have been clustered close together.
Hubble's discovery was the first observational support for **Georges Lemaitre's Big Bang theory of the universe**, proposed in 1927. Lemaitre proposed that the universe expanded explosively from an extremely dense and hot state (scientists call it as the **Singularity**), and continues to expand today.

An alternative to this was **Hoyle's concept of steady state.** It considered the universe to be roughly the same at any point of time.
Other theories formulating the origin of Universe includes Theory of Mirage of a Black Hole, Plasma Theory of creation of Universe and White Hole Theory

(These don't require detailed explanation, knowing the name of such theories is enough at this stage)

However, with greater evidence becoming available about the expanding universe, scientific community at present favours argument of expanding universe.

**Formation of Galaxies and Stars**

- The distribution of matter and energy was not even in the early universe.
- These initial density differences gave rise to differences in gravitational forces and it caused the matter to get drawn together. These formed the bases for development of galaxies. A galaxy contains a large number of stars.
- A galaxy starts to form by accumulation of hydrogen gas in the form of a very large cloud called **nebula**.
- Eventually, growing nebula develops localised clumps of gas. These clumps continue to grow into even denser gaseous bodies, giving rise to formation of stars.
- The formation of stars is believed to have taken place some 5-6 billion years ago.

**Our Solar System**

- The nebula from which our Solar system is supposed to have been formed, started its collapse and core formation some time 5-5.6 billion years ago and the planets were formed about 4.6 billion years ago.
- Our solar system consists of the sun (the star), 8 planets, 63 moons, millions of smaller bodies like asteroids and comets and huge quantity of dust-grains and gases.
- Our Sun
    - The sun is by far the largest object in our solar system, containing 99.8% of the solar system's mass.
    - According to NASA, with the use of spectrographs, it clear that Sun is made up of gas, about 91% hydrogen and 8.9% helium.
    - Compared with other stars, the sun is relatively small and just one of the billions of stars in the Milky Way.
    - The temperature at its surface is about 5500 degrees Celsius. In the centre, the temperature is about 15 million degrees Celsius. Interestingly, temperature of the corona, outermost region of the Sun's atmosphere, is more than 1 million degrees Celsius.

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- At such high temperatures and pressures, the Sun becomes a nuclear reactor, where hydrogen is converted to helium. At the same time, huge amounts of radiation are produced.
- Its period of surface rotation is about 26 days at its equator but longer at higher latitudes.
- **Every 11 years or so,** the Sun's magnetic field completely flips. This means that the Sun's north and south poles switch places. Then it takes about another 11 years for the Sun's north and south poles to flip back again.
- The solar cycle affects activity on the surface of the Sun, such as sunspots which are caused by the Sun's magnetic fields.
    - **Sunspots** are phenomena on the Sun's photosphere that appear as temporary spots that are darker than the surrounding areas. They are regions of reduced surface temperature caused by **concentrations of magnetic flux** that inhibit convection (heat transfer).
    - One way to track the solar cycle is by counting the number of sunspots. The beginning of a solar cycle is a solar minimum, or when the Sun has the least sunspots. Over time, solar activity—and the number of sunspots—increases.
    - The **middle of the solar cycle is the solar maximum,** or when the Sun has the most sunspots. As the cycle ends, it fades back to the solar minimum and then a new cycle begins.
    - The **current solar cycle,** which **began in 2008,** is in its **'solar minimum'** phase, when the number of Sunspots and solar flares is at a routine low.
- At the peak of the sunspot cycle, there are many more explosive solar storms, which are harmful for modern human life on earth.
- Sun's atmosphere produces a stream of charged particles (mainly protons and electrons) that are called the **solar wind**. These particles flow outward from the Sun into the solar system at a speed of about 400 kilometres per second. The solar wind exists because the gases in the corona are so hot and moving so rapidly that they cannot be held back by solar gravity.
- Recent probe by **NASA to the Sun, Parker Solar Probe,** has become the first man-made object to touch the surface of Sun and has provided great scientific insights into the working of Sun and the Solar winds.

Solar flares are sometimes accompanied by a **Coronal Mass Ejection (CME).**

- CMEs are huge bubbles of radiation and particles from the **Sun's Corona (outermost region of the Sun's atmosphere).** They explode into space at very high speed when the Sun's magnetic field lines suddenly reorganize.
- They can trigger intense light in the sky on Earth, called **auroras.**
    - Some of the energy and small particles travel down the magnetic field lines at the north and south poles into Earth's atmosphere.
    - There, the particles **interact with gases in the atmosphere resulting in beautiful displays of light in the sky.** Oxygen gives off green and red light. Nitrogen glows blue and purple.
    - The aurora in Earth's northern atmosphere is called an **aurora borealis or northern lights.** Its southern counterpart is called an **aurora australis or the southern lights.**

**How does the solar cycle affect Earth?**

- The more charged-up the solar wind headed towards Earth, the brighter and more frequent are the displays of Northern Lights and Southern Light (Aurora)
- For example, the solar storm of 1859 struck the Earth with such intensity that the northern lights were visible as far from the poles as Cuba and Hawaii.
- Power outages, satellite malfunctions, communication disruptions, and GPS receiver malfunctions are other few things that can happen during a solar maximum.

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- Continuing with the remaining objects of our solar system, we have eight planets out of which
    - Mercury, Venus, Earth and Mars are called as the **inner planets** as they lie between the sun and the belt of asteroids. They are also called Terrestrial, meaning earth-like as they are made up of rock and metals, and have relatively high densities. They are composed mainly of **silicates and metals**. Except Mercury all have atmospheres substantial enough to generate weather; all have impact craters and tectonic surface features, such as rift valleys and volcanoes.
    - Jupiter, Saturn, Uranus and Neptune are the other four planets that are called the outer planets. They are also called Jovian or Gas Giant planets. Jovian means jupiter-like. Most of them are much larger than the terrestrial planets and have thick atmosphere, mostly of helium and hydrogen.
- The difference between terrestrial and jovian planets can be attributed to the following conditions:
    - The terrestrial planets were formed in the close vicinity of the parent star where it was too warm for gases to condense to solid particles. Jovian planets were formed at quite a distant location.

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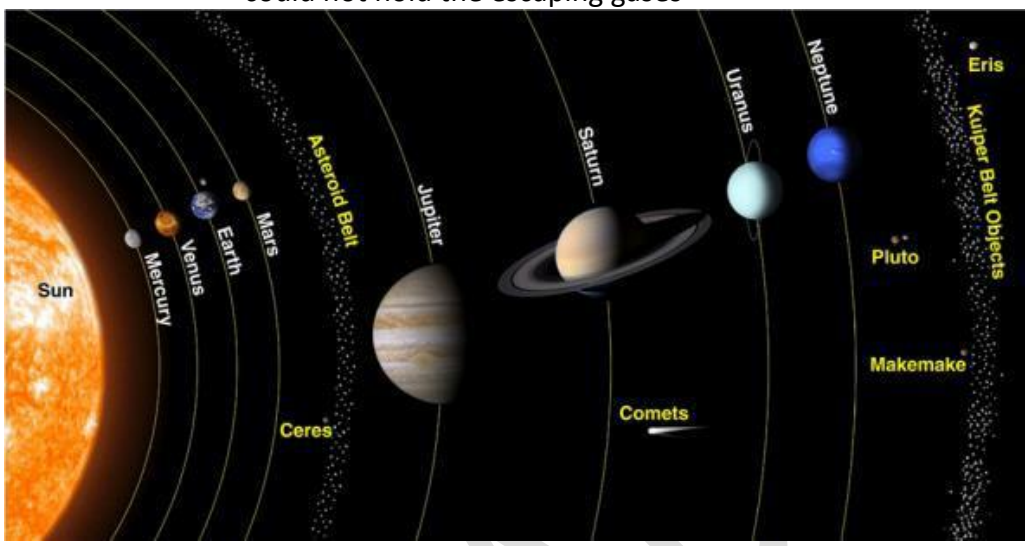
- The solar wind was most intense nearer the sun; so, it blew off lots of gas and dust from the terrestrial planets. The solar winds were not all that intense to cause similar removal of gases from the Jovian planets.
- The terrestrial planets are smaller and their lower gravity could not hold the escaping gases




- Till August 2006, Pluto was also considered a planet. However, in a meeting of the International Astronomical Union, a decision was taken that Pluto like other celestial objects (2003 UB313) discovered in recent past may be called 'dwarf planet'.

## Brief Overview of our Planets

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| **Mercury** | • **Geologically inactive for billions of years** because there is **no atmosphere** on Mercury<br>• It may appear as a bright star-like object but is **less bright than Venus**.<br>• It has surface temperatures that vary diurnally more than on any other planet in the Solar System (−173 °C at night to 427 °C during the day) because of lack of atmosphere. |
| **Venus** | • It is the **brightest planet** in the solar system and is the third brightest object visible from earth after the sun and the moon.<br>• The surface of Venus is totally **obscured** by a thick atmosphere composed of about **96% carbon dioxide**, covered with clouds of highly reflective sulfuric acid.<br>• The atmospheric pressure at the planet's surface is 92 times that of Earth (roughly found at 900 m (3,000 ft) underwater on Earth).<br>• Venus is by far the **hottest planet** in the Solar System, even though Mercury is closer to the Sun. This is |

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| | because of the **greenhouse effect** arising from high concentrations of $CO_2$ and thick atmosphere.<br>• It is the brightest among planets because it has the **highest albedo** due to the **highly reflective sulfuric acid** that covers its atmosphere.<br>• It is also considered as Earth's **sister planet** or **Earth's twin** because of their similar size, mass, bulk composition and similar physical features such as high plateaus, folded mountain belts, volcanoes, etc.<br>• A day on Venus is equivalent to 243 earth days and **lasts longer than its year** (224 days).<br>• It **rotates in the opposite direction (clockwise)** to most other planets.<br>• In the ancient literature, Venus was often referred to as the **morning star** and **evening star**. |
| **Mars** | • It is often referred to as the "Red Planet" because of the **reddish iron oxide** prevalent on its surface.<br>• Mars can easily be seen from Earth with the naked eye. Mars is less dense than Earth, having about 15% of Earth's volume and 11% of Earth's mass.<br>• Mars has a thin atmosphere and has surface features ranging from impact craters of the Moon and the valleys, deserts, and polar ice caps of Earth.<br>• Mars has two irregularly shaped moons, **Phobos** and **Deimos**, which are thought to be captured asteroids.<br>• Liquid water cannot exist on the surface of Mars due to **low atmospheric pressure** (less than 1% of the Earth's).<br>• Mars is the site of **Olympus Mons** (shield volcano), **the largest volcano** and the **highest known mountain** (24 km) **in the Solar System**.<br>• Landforms visible on Mars strongly suggest that **liquid water has existed** on the planet's surface.<br>• Mars lost its magnetosphere 4 billion years ago, possibly because of numerous asteroid strikes, so the solar wind interacts directly with the Martian ionosphere, lowering the atmospheric density.<br>• The atmosphere of Mars consists of about **96% carbon dioxide**, 1.93% argon and 1.89% nitrogen along with traces of oxygen and water.<br>• **Methane** has been detected in the Martian atmosphere (**may indicate the existence of life**).<br>• Methane can exist in the Martian atmosphere for only a limited period before it is destroyed — estimates of its lifetime range from 0.6-4 years. |
| **Jupiter** | • It is composed mostly of gas and liquid swirling in complex patterns with **no solid surface**. |

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| | • Jupiter's four large moons (**Io, Europa, Ganymede, and Callisto**), called the **Galilean satellites** because Galileo discovered them.<br>• Because of its **rapid rotation** (once every 10 hours), the planet's shape is that of an oblate spheroid (slight bulge at the equator).<br>• The outer atmosphere is visibly segregated into several bands, resulting in turbulence and storms. |
| **Saturn** | • Saturn's rings are probably made up of billions of particles of ice and ice-covered rocks.<br>• **Titan** is the second-largest moon in the Solar System (larger than Mercury) and it is the only satellite in the Solar System with a **substantial atmosphere** (nitrogen-rich). |
| **Uranus** | • Unlike other planets, it **spin on its sides**, that is its axis of rotation lies in nearly the plane of its orbit. (The poles of Uranus lie in a plane where equators of other planets lie)<br>• **Venus** and **Uranus** have a **retrograde rotation** (**clockwise**), i.e., opposite of sun's rotation. The other six planets rotate about their axis in the direction of sun's rotation i.e **counterclockwise**.<br>• All eight planets in the Solar System revolve the Sun in the direction of the Sun's rotation, which is **counterclockwise** when viewed from above the Sun's north pole. |
| **Neptune** | • Uranus and Neptune (the ice giants) are called the **twins** of the outer solar system.<br>• They are surrounded by a thick atmosphere of hydrogen and helium and contains a higher proportion of "ices" such as water, ammonia, and methane ice giants" to emphasise this distinction. |

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## Other Solar System Objects

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| **Asteroids** | • Asteroids are small, rocky objects that orbit the Sun.<br>• Most asteroids are found orbiting in the Asteroid Belt, a series of rings located between the orbits of Mars and Jupiter.<br>• Most asteroids are irregular in shape because they are too small to exert enough gravitational pull to become spherical in shape.<br>• Some asteroids are blown out comets. When the ice is gone, all that remains is the rocky material. |

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| **Meteorites** | • A meteoroid is a chunk of space rock. If it burns up while entering the Earth's atmosphere it's called a meteor and if a piece lands, it's called a meteorite.<br>• Millions of meteoroids travel through the Earth's atmosphere every day, but most are small and burned up quickly. Very few reach the ground.<br>• A meteorite that is seen or detected as it lands are called "falls", with those that are discovered later being referred to as "finds". Meteoroids more than 10 metres in diameter are classified as asteroids. |
| **Comets** | • Comets, like asteroids, are small celestial bodies that orbit the Sun. However, unlike asteroids, comets are composed primarily of frozen ammonia, methane or water, and contain only small amounts of rocky material. As a result of this composition comets have been given the nickname of "dirty snowballs."<br>• A comet has four components: a nucleus, a coma, a dust tail and an ion tail.<br>• Comets are believed to originate in one of two regions – the theorized Oort Cloud, or the Kuiper Belt found beyond the orbit of Neptune and the dwarf planet Pluto. |

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**Kuiper Belt**

- It is similar to the asteroid belt found between the orbits of Mars and Jupiter, but it is 20 times as wide and somewhere between 20- 200 times more massive.
- The ices are frozen volatiles that are made up of methane, nitrogen, ammonia and water.
- At least three dwarf planets are located in the Kuiper belt: Pluto, Haumea and Makemake.

***The story of universe is incomplete*** with only the mention of stars and galaxies. Astronomical and physical calculations suggest that the visible universe is only 4% of what the universe is actually made of.

- A very large fraction of the universe, in fact 26%, is made of an unknown type of matter called *Dark matter*. Unlike stars and galaxies, dark matter does not emit any light or electromagnetic radiation of any kind, so that we can detect it only through its gravitational effects
- An even more mysterious form of energy called *Dark Energy* accounts for about 70% of the mass-energy content of the universe. Even less is known about it than dark matter. This idea stems from the observation that all galaxies seem to be receding from each other at an accelerating pace, implying that some invisible extra energy is at work.

***Did You Know?***

- NASA's **Chandra X-ray Observatory** and optical telescopes help map the distribution of dark matter in colliding galaxy.
- The Very Energetic Radiation Imaging Telescope Array System (**VERITAS**) in Arizona, which can detect gamma-ray radiation, is looking for the signature of dark matter annihilation.
- The **South Pole Telescope in Antarctica** and Chandra are placing limits on dark energy by looking for its effects on galaxy cluster evolution throughout the history of the Universe.

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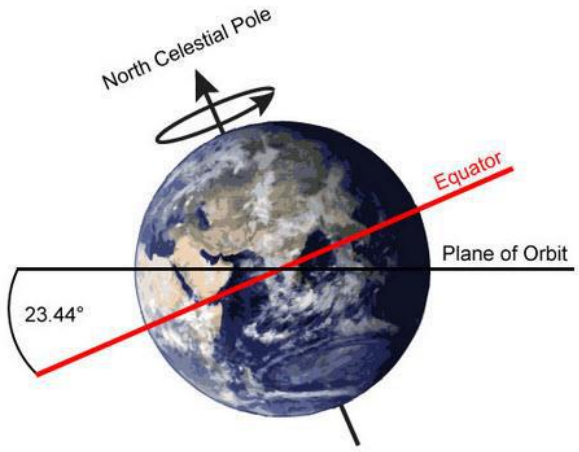
## Cosmic Microwave Background

- The cosmic microwave background (or CMB) fills the entire Universe and is leftover radiation from the Big Bang. The universe is still expanding today, and the expansion rate appears different depending on where you look. The CMB represents the heat leftover from the Big Bang.
- We can't see the CMB with our naked eye, but it is everywhere in the universe.
- It is invisible to humans because it is so cold, just 2.725 degrees above absolute zero (minus 459.67 degrees Fahrenheit, or minus 273.15 degrees Celsius.)
- This means its radiation is most visible in the microwave part of the electromagnetic spectrum.
- The universe began 13.8 billion years ago, and the CMB dates back to about 400,000 years after the Big Bang. That is because in the early stages of the universe when it was just one-hundred-millionth the size it is today, its temperature was extreme: 273 million degrees above absolute zero.
- The CMB is useful to scientists because it helps us learn how the early universe was formed.
- It is at a uniform temperature with only small fluctuations visible with precise telescopes.
- By studying these fluctuations, cosmologists can learn about the *origin of galaxies and large-scale structures of galaxies and they can measure the basic parameters of the Big Bang theory*.
- The first space mission specifically designed to study the cosmic microwave background (CMB) was the Cosmic Background Explorer (COBE), launched by NASA in 1989
- NASA's Wilkinson Microwave Anisotropy Probe(WMAP) in 2001
- European Space Agency's – Planck in 2009

Notes

## ROTATION OF EARTH




- 'Rotation' refers to an object's spinning motion about its own axis. Earth also spins around a central line called an axis.
- Earth rotates along its axis from west to east.
- It takes approximately 24 hrs to complete one rotation.
- Days and nights occur due to rotation of the earth.
- The circle that divides the day from night on the globe is called the circle of illumination.
- Earth rotates on a tilted axis that makes an angle of 23.5° with the orbital plane.
- Rotation Movement of earth on its axis for 24 hours is called Earth day.

*What happens If Earth didn't rotate?*
*The portion of the earth facing the sun would always experience day, thus bringing continuous warmth to the region. The other half would remain in darkness and be freezing cold all the time. Life would not have been possible in such extreme conditions.*

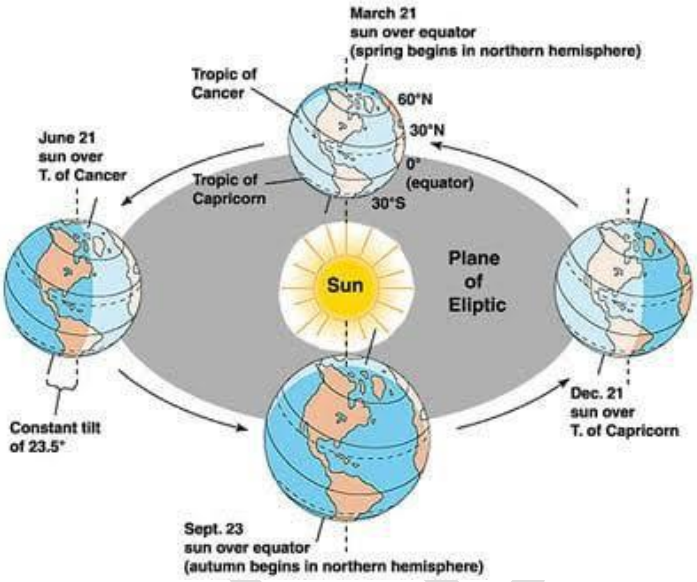
**Effects of Rotation**

- Rotation creates a diurnal cycle of light and darkness, temperature, and humidity changes.
- Rotation causes **the tides**- the twice daily rise and fall of sea level.
- Rotation requires the creation of standardized time zones. There are 24, one for each hour of the earth's rotation.
- The **Coriolis Force.** When the Earth rotates on its axis, it prevents air currents from moving in a straight line north and south from the equator. Instead, it results in one of the effects of rotation of the Earth: the Coriolis Effect. This deflects winds to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

Because one rotation takes 24 hours, one might think that each side of Earth spends approximately 12 hours facing the Sun and 12 hours in darkness. This is true of places located on or near the equator. However, as one moves towards the North and South Poles, the length of daytime and nighttime varies. The closer a city is to the North or South Pole, the more extreme the difference in daylight hours and night time hours are. This is due to the tilt of the axis and Earth's revolution around the Sun

Notes

## REVOLUTION OF EARTH




- The motion of the earth around the sun in its orbit is called revolution.
- It takes 365¼ days (one year) to revolve around the sun.
- 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.
- Revolution leads to change in Seasons.
- During one revolution around the Sun, Earth travels at an average distance of about 150 million km.
- Earth revolves around the Sun at an average speed of about 27 km (17 mi) per second, but the speed is not constant. The planet moves slower when it is at aphelion and faster when it is at perihelion.
- 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.

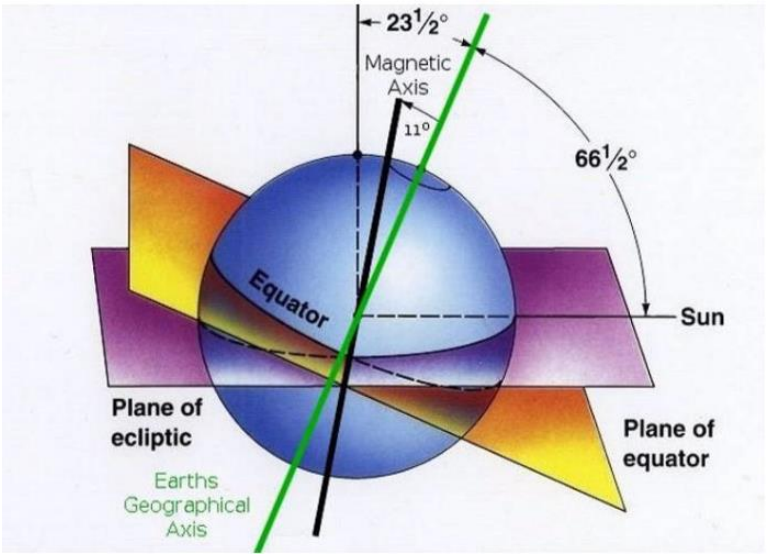
**Effects of revolution**

- Revolution along with the earth's tilted axis leads to changing seasons across the hemispheres.
- The speed of the Earth's revolution has influenced the state of the Earth. On account of the speed of pivot, a diffusive power is made which prompts the straightening of the Earth at shafts and protruding at the middle.
- The Earth's revolution influences the development of water in the seas. The tides are redirected because of the turn.
- The speed of revolution additionally influences the development of the breeze. Because of revolution, winds and the sea flow redirect to one side in the Northern Hemisphere and to one side in the Southern Hemisphere.

Notes

**Earth's Magnetic Axis:**

Apart from the various axis mentioned above, the earth also has a magnetic axis. It is represented by a field of a magnetic dipole currently tilted at an angle of about 11° with respect to Earth's rotational axis, as if there were an enormous bar magnet placed at that angle through the center of Earth.
The North geomagnetic pole actually represents the South Pole of Earth's magnetic field, and conversely the South geomagnetic pole corresponds to the north pole of Earth's magnetic field.



## LATITUDES AND LONGITUDES

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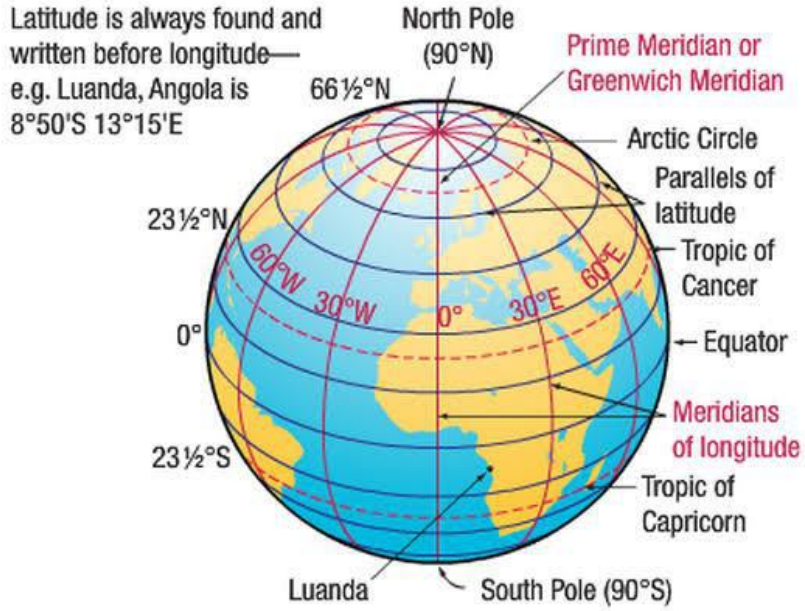


| LATITUDES | LONGITUDES |
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| The angular distance of a place north or south of the earth's equator | The angular distance of a place east or west of the Prime meridian (also known as Greenwich Meridian) |
| Latitudes are named south and north of equator | Longitudes are named east or west of prime meridian |
| Equator is the 0° latitude | Prime meridian is the 0° longitude |
| Their length decreases from equator to poles. | All longitudes are equal in length. |
| The distance between two successive lines of latitude remain constant (111km) because latitudes run parallel to each other and never meets the other latitude | Distance between two longitude decreases as we move towards pole.<br><br>Finally, all longitudes meet at the Poles |
| They help in determining the intensity of sunlight received at a point. | Used to determine time and date at a location. |
| Equator, Tropic of Cancer (23.5° N), Tropic of Capricorn (23.5° S), Arctic circle (66.5° N), Antarctic circle (66.5° S), North Pole (90° N) and South Pole (90° S) are important latitudes | Prime meridian (0°) and International Date Line (180° E or 180° W) are important longitudes |

## SUMMER SOLISTICE

- On 21st June, the Northern hemisphere is tilted towards the sun. The rays of the sun fall directly on the Tropic of Cancer (23.5° N). 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 (66.5° N) 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.

## WINTER SOLISCTICE

- 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 (23½° S), 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 and it experiences winter. This position of the earth is called the winter solstice.

## 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.

Notes

## Local Time

- The time at a particular place with reference to the overhead position of the sun in the sky is considered as the local time of that place.
- Local time of a particular place is determined by the mid-day sun. All places on the same meridian experience noon at the same time.
- As the Earth rotates 360º in 24 hours, in 1 hour it would rotate 360º/24º or 15º. Similarly, the earth would take 4 minutes to rotate 1º.
- As the Earth rotates from west to east, places to the east see the sun first and so the time is ahead, while places to the west see the sun later and so are behind the time.
- Hence, if the time at Greenwich or 0º meridian is noon, it would be 12.04 pm at 1º E and 11.56 am at 1º W and similarly it would be11 am at 15º W and 1 pm at 15º E.

## Standard Time

- Standard time is the local time in a country or region when Daylight Saving Time (DST) is not in use. It is sometimes referred to as or winter time or normal time, while DST may also be called summer time, especially in the UK.
- **Standard Time** is the time of a region or country that is established by law or general usage as civil time.
- More than 60% of the countries in the world use standard time all year. The remaining countries use DST during the summer months, generally setting clocks forward 1 hour from standard time.
- The concept was adopted in the late 19th century in an attempt to end the confusion that was caused by each community's use of its own solar time.
- Some such standard became increasingly necessary with the development of rapid railway transportation and the consequent confusion of schedules that used scores of different local times kept in separate communities. (Local time varies continuously with change in longitude.)
- The need for a standard time was felt most particularly in the United States and Canada, where long-distance railway routes passed through places that differed by several hours in local time.
- The present system employs 24 standard meridians of longitude (lines running from the North Poleto the South Pole, at right angles to the Equator) 15° apart, starting with the prime meridian through Greenwich, England.
- In a few regions, however, the legal time kept is not that of one of the 24 Standard Time zones, because half-hour or quarter-hour differences are in effect there.
- In addition, Daylight Saving Time is a common system by which time is advanced one hour from Standard Time, typically to extend daylight hours

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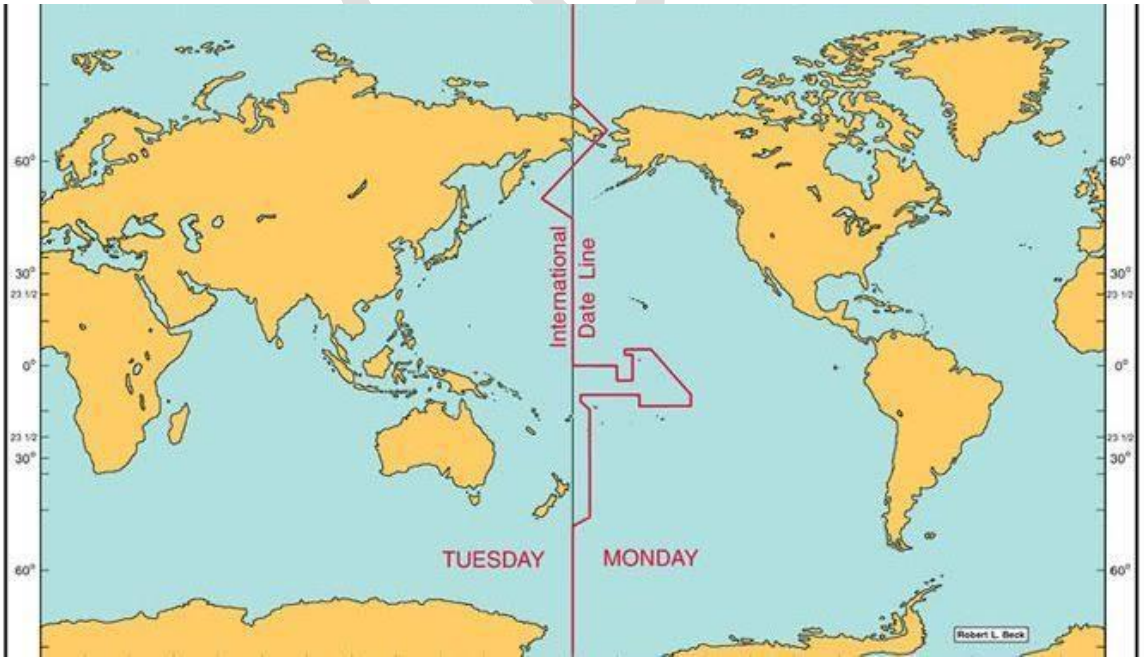
during conventional waking time and in most cases for part of the year (usually in summer).

Notes

## INTERNATIONAL DATE LINE

- The International Date Line serves as the "line of demarcation" between two consecutive calendar dates.
- It is located halfway round the world from the prime meridian ($0^o$)
- The dateline runs from the North Pole to the South Pole and marks the divide between the Western and Eastern Hemisphere.
- It passes through the middle of the Pacific Ocean, roughly following the 180° line of longitude with deviations in certain regions
- It is not straight but zigzags to avoid political and country borders and to not cut some countries in half.
- IDL deviates eastward through the Bering Strait to avoid dividing Siberia and then deviates westward to include the Aleutian Islands with Alaska.
- International Date Line is where the date changes by exactly one day when it is crossed.
- A traveller crossing the date line from east to west loses a day and while crossing the dateline from west to east he gains a day (refer below diagram)



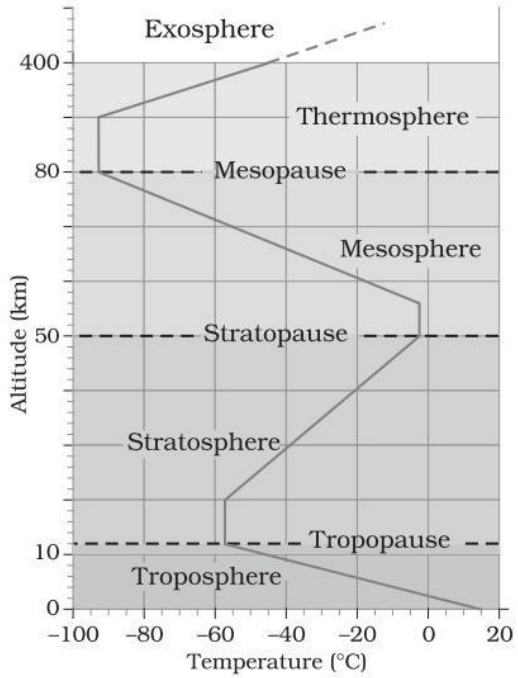
# CLIMATOLOGY - LAYERS OF ATMOSPHERE, TEMPERATURE INVERSION

Notes

## 1. COMPOSITION OF ATMOSPHERE

| *Constituent* | *Formula* | *Percentage by Volume* |
|---|---|---|
| Nitrogen | $N_2$ | 78.08 |
| Oxygen | $O_2$ | 20.95 |
| Argon | Ar | 0.93 |
| Carbon dioxide | $CO_2$ | 0.036 |
| Neon | Ne | 0.002 |
| Helium | He | 0.0005 |
| Krypto | Kr | 0.001 |
| Xenon | Xe | 0.00009 |
| Hydrogen | $H_2$ | 0.00005 |

## 2. LAYERS OF ATMOSPHERE




| LAYERS | ALT. (Km) | TEMP. (°C) | FEATURES |
|---|---|---|---|
| Troposphere | 8 ( near pole) to 18 (near equator) | 15 to -56 | • Lowest layer of Earth's atmosphere.<br>• All weather phenomena occurs within this layer.<br>• This layer has water vapour (wettest layer) and mature particles.<br>• Temperature decreases at the rate of 1 degree Celsius for every 165 m of height.<br>• Tropopause separates Troposphere and Stratosphere. |

| | | | |
|---|---|---|---|
| Stratosphere | 11 to 50 | -56 to -0 | • This layer is very dry as it contains little water vapour.<br>• Advantages for flight because it is above stormy weather and has steady, strong, horizontal winds.<br>• Ozone layer is found in this layer.<br>• Ozone layer absorbs UV rays and safeguards earth from harmful radiation<br>• Temperature in the stratosphere rises with increasing altitude (called temperature inversion) because the ozone layer absorbs the greater part of the solar ultraviolet radiation.<br>• Stratopause separates Stratosphere and Mesosphere |
| Mesosphere | 50 to 80 | -0 to -90 | • It is the coldest of the atmospheric layers.<br>• The temperature drops with altitude in this layer.<br>• Meteors burn up in this layer.<br>• The upper limit is called Mesopause which separates Mesosphere and Thermosphere |
| Thermosphere | **85 and above** | -92 to 1200 | • Radio waves which are transmitted from the earth are reflected back by this layer.<br>• The temperature increases with height.<br>• Aurora and satellites (ex: International Space Station) occur in this layer. |
| Ionosphere | 80 to 600 | >1200 | • The lower Thermosphere is called the Ionosphere.<br>• Ionosphere consists of electrically charged particles known as ions.<br>• This layer is defined as the layer of the atmosphere of Earth that is ionized by cosmic and solar radiation.<br>• Temperature starts increasing with height because of radiation from the sun |

Notes

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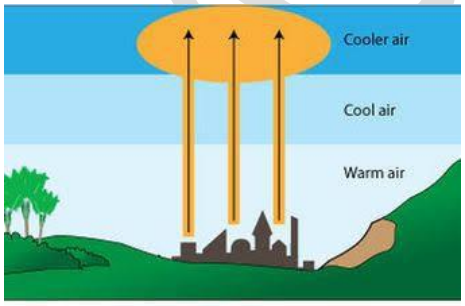
|---|---|---|---|
| Exosphere | >600 | >1200 | • It is the outermost layer of the atmosphere.<br>• The zone where molecules and atoms escape into space is mentioned as the exosphere.<br>• It extends from the top of the thermosphere up to 10,000 km.<br>• The air is extremely rarefied and the temperature gradually increases through the layer (as it is exposed to direct sunlight) |

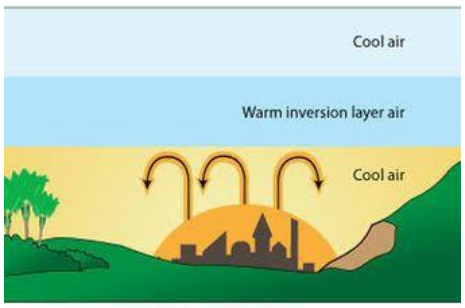
Notes

## TEMPERATURE INVERSION

- Normally, temperature decreases with increase in elevation. It is called normal lapse rate.
- At times, the situation is reversed and the normal lapse rate is inverted. It is called Inversion of temperature.
- A long winter night with clear skies and still air is ideal situation for inversion. The heat of the day is radiated off during the night, and by early morning hours, the earth is cooler than the air above. Over polar areas, temperature inversion is normal throughout the year.
- Surface inversion promotes stability in the lower layers of the atmosphere. Smoke and dust particles get collected beneath the inversion layer and spread horizontally to fill the lower strata of the atmosphere.
- Dense fogs in mornings are common occurrences especially during winter season. This inversion commonly lasts for few hours until the sun comes up and begins to warm the earth.



Normal pattern



Thermal inversion

The inversion takes place in hills and mountains due to air drainage. Cold air at the hills and mountains, produced during night, flows under the influence of gravity. Being heavy and dense, the cold air acts almost like water and moves down the slope to pile up deeply in pockets and valley bottoms with warm air above. This is called air drainage. It protects plants from frost damages.

**Social relevance of temperature inversion:**

The inversion of temperature and its duration affects adversely the society and economy of the region of its

occurrence. Some of the important consequences of temperature inversion are

- **Occurrence of fog:** there develops clouds in contact with the ground(fog) with visibility usually restricted less than 1km. in the urban areas, the fog mixed with smoke takes the shape of smog. While fog is injurious to crops, the smog is considered as a health hazard. In 1952, about 4000 people died of smog in London. Breathing problems, asthma and bronchitis etc. are common problem in Delhi and big cities of the northern India during the winter season.
- **Road accidents:** The frequency of road, railways and air accidents increases during foggy conditions due to low visibility. The trains and flights are often delayed.
- **Damage of crops:** The winter crops like wheat, barley, mustard, vegetables, chilies, potato etc. are seriously damaged. The sugarcane crop in the northern plains of India. Especially in UP, Punjab and Haryana develop the disease of red rot which reduces the sugar content.
- **Vegetation:** Orchards are closely influenced by the inversion of temperature. The lower valleys of alps mountains are almost without settlements, while the upper slopes are inhabited.

**Fog**

- Fog is simply a cloud on the ground.
- When the temperature of an air mass containing a large quantity of water vapour falls all of a sudden, condensation takes place within itself on fine dust particles.
- So, the fog is a cloud with its base at or very near to the ground. Because of the fog and mist, the visibility becomes poor to zero.

**Types of fog:**

- **Radiation fog** results from radiation, cooling of the ground and adjacent air. These fogs are **not very thick**. Usual in winters.
- Fogs formed by condensation of warm air when it moves horizontally over a cold surface, are known as **advectional fog**. These fogs are **thick and persistent**. Occurs over warm and cold water mixing zones in oceans.
- **Frontal or precipitation fog** is produced due to convergence of warm and cold air masses where warm air mass is pushed under by the heavier cold air mass.

In urban and industrial centers smoke provides plenty of nuclei which help the formation of fog and mist. Such a condition when fog is mixed with smoke, is described as **smog**

Notes

**Mist**

- The difference between the mist and fog is that mist contains more moisture than fog.
- In mist each nuclei contains a thicker layer of moisture.
- Mists are frequent over mountains as the rising warm air up the slopes meets a cold surface.
- Mist is also formed by water droplets, but with less merging or coalescing. This means mist is less dense and quicker to dissipate.
- Fogs are drier than mist and they are prevalent where warm currents of air come in contact with cold currents.
- In mist visibility is between 1-2 kms.

Notes