TNPSC GROUP I & II CLASS NOTES

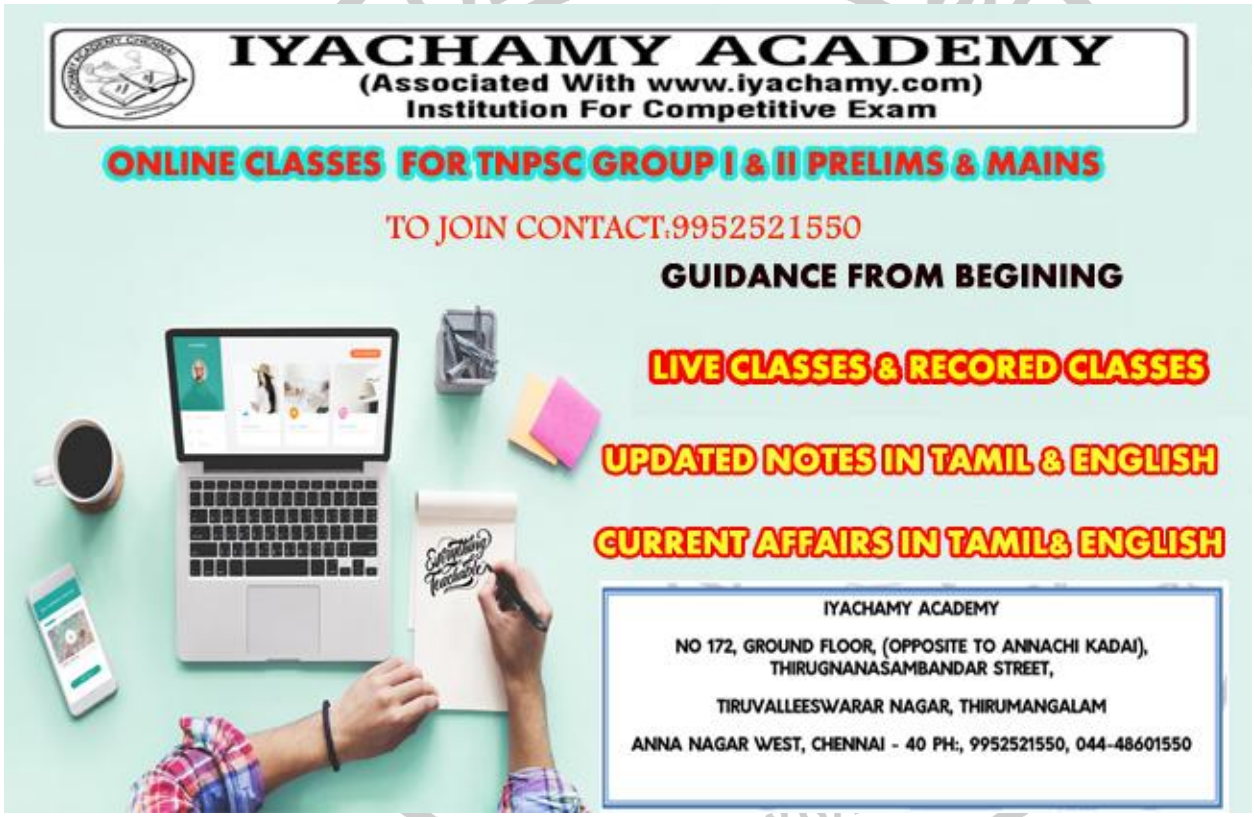
UNIVERSE, EARTH,ROCKS,TIMEZONE

What is the universe?

Speaking generally, universe means everything—all we see and cannot see.

What is a galaxy?

A galaxy is a system of billions of stars, stellar remnants, interstellar gas, dust, and dark matter. The word galaxy is derived from the Greek word Galaxias, literally "milky", a reference to the Milky Way The Milky Way is the galaxy that contains our Solar System.



Galaxies are in three major forms:

Spiral Galaxies: It consists of a flat and rotating disk of stars, gases and dust. It has a central concentration of stars known as the 'bulge'. The Milky Way and the Andromeda are spiral galaxies.

Elliptical Galaxies: It contains older stars with fewer gases. Messier89 galaxy is an elliptical galaxy.

Irregular Galaxies: They are youthful galaxies with more dust and gases. This can make them very bright. Large Magellanic Cloud is an example of irregular galaxy

What is a star?

A star is a great ball of fire. It is necessarily a ball: like a planet, it forms from a spinning cloud of dust and gas that collapses under its own gravity, pulling inward equally in all directions. And it is necessarily great: unlike the smaller planets, its sheer mass exerts a pressure that sets off a nuclear fire, which in most cases burns for billions of years.

The closest star, our own star, is the Sun. Outside of our Sun; our system's nearest neighbor is Alpha Centauri.

Beginning of the universe?

Dating the beginning has been a matter of running the clock backward to a first moment, known as the Big Bang, when the observable universe began its expansion.

If "Big Bang" seems too jokey a name for something so momentous, it is because it got the name from scientists who did not believe it. The idea was first suggested in the 1920s by Monsignor Georges Lemaître, a Belgian priest and physicist, who described the source of the universe as a "primeval atom." or the "Cosmic Egg".

What is a planet?

a planet could be safely defined as any of nine bodies that revolve around the Sun. Outward from the Sun, they are Mercury, Venus, Earth, and Mars (the "terrestrial," or Earth-like, planets), Jupiter, Saturn, Uranus, and Neptune (the "gas giants"), and Pluto.

The inner planets or terrestrial planets or rocky planets. Mercury, Venus, Earth and Mars are called inner or terrestrial planets.

The outer planets or gaseous planets or giant planets. Jupiter, Saturn, Uranus and Neptune are called outer or gaseous planets.

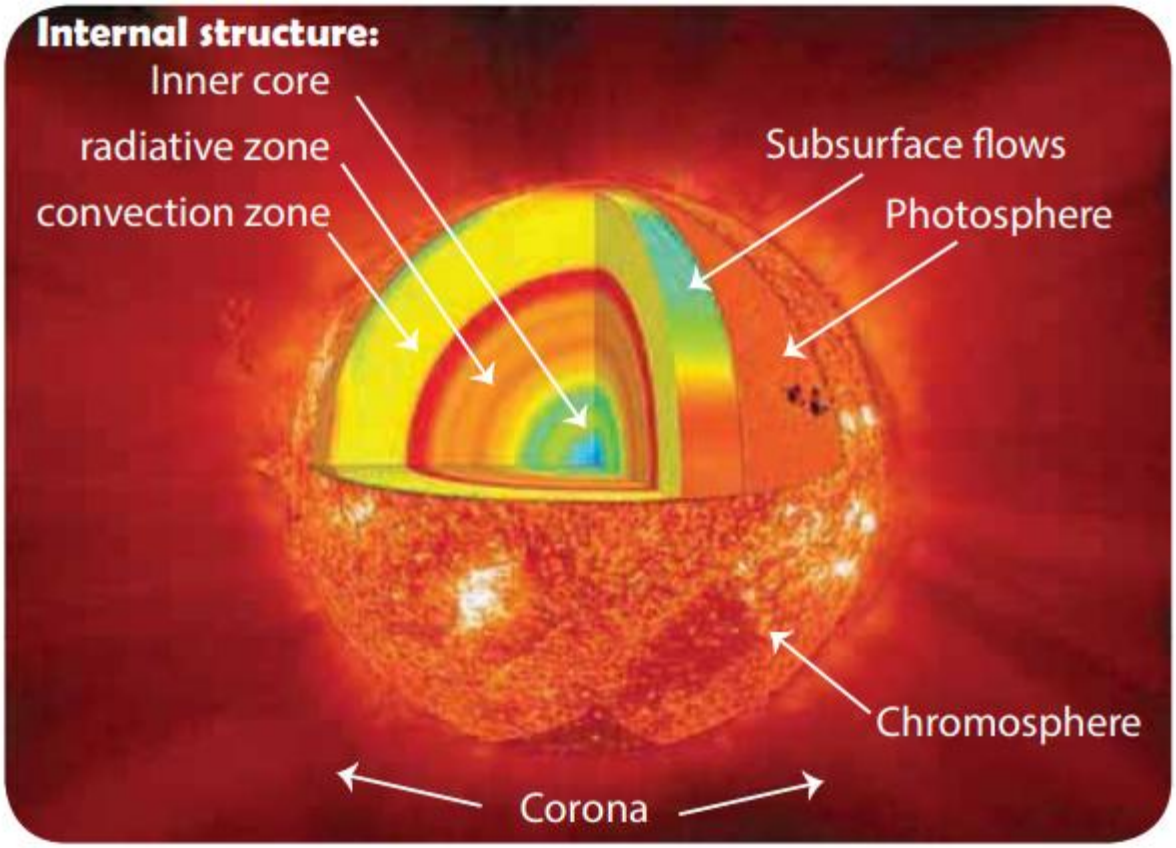
International Astronomical Union (IAU) had voted to strip Pluto of its status as a planet. Its demotion to "dwarf planet"

Solar system

The solar system consists of a central star, the Sun, and all of the smaller celestial bodies that continuously travel around it. The smaller bodies include eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune, which are themselves orbited by more than 140 moons. (Only Mercury and Venus have no moons.) In addition, the solar system contains millions of rocky asteroids and billions of icy comets. The solar system is about 4.6 billion years old. The closest planet to Sun is Mercury and the farthest is Neptune. Jupiter is the biggest planet in the Solar System and Mercury is the smallest.

The Sun

The Sun is the primary source of energy for life on Earth. It is the closest star to the Earth, about 150 million kilometers from earth. The temperature of the Sun's visible surface (photosphere) is about 6000 degree Celsius. However, the outer layer of Sun's atmosphere, known as the Corona, is, on an average, about 2 million degree Celsius. The core of the sun is the center, and is about 15 million degree Celsius. The Sun is made up of 73% hydrogen and 25% helium. It also has trace amounts of oxygen, carbon, iron and other elements. It is classified as a G-Type Main Sequence Star. It is about 4.6 billion years old and will continue to shine for another 5 billion years. After that it will grow into a Red Giant and then finally end its life as a white dwarf.



Mercury

Closest planet to the Sun.Orbits the Sun the quickest. No significant atmosphere.Rotation period is longer than its orbital (revolution) period.No natural satellites (moons).

Venus

Known as Earth's twin. Longest rotation period of any planet.Rotation period is longer than its orbital (revolution) period.Hottest planet in the solar system.Dense atmosphere of gases and chemicals including sulphuric acid clouds.Revolves around the sun in clockwise manner while most others are revolving in anti-clockwise. Second brightest natural object in the night sky (after Moon).Can be seen from the earth only before sunrise (Morning Star) and after sunset (Evening Star).No natural satellites (moons).

Earth

Only planet in the solar system to be known to support life.Has water in all three states – liquid, solid and gas.Gasses present in the earth's atmosphere are Nitrogen, Hydrogen, Oxygen, Carbon Dioxide etc It takes 23 hour 56

minutes 46 seconds to rotate around its axis. It takes 365.26 days to revolve around the Sun. The Ozone layer present in the Earth's atmosphere protects it from the ultra violet rays. Moon is the only natural satellite of the Earth.

Mars

Known as the 'Red Planet' due to presence of iron-rich red soil. Despite its red colour, it is cold because it has lost most of its atmosphere. Phobos and Deimos are the two moons of Mars. Has polar ice caps and traces of sub-terrestrial liquid water has been found. Has the largest known volcano (and second tallest mountain) in the solar system – Mons Olympus. Spacecrafts to Mars: Mariner 4, 2001 Mars Odyssey, Mars Orbiter Mission (India), MAVEN etc.

Jupiter

Largest planet of the solar system. Has two and a half times the mass of all other planets put together. Has the shortest rotation period.A gas giant, primarily composed of hydrogen and helium with no discernible solid surface.Has a giant storm (three times the diameter of earth) since 1831 called the 'Great Red Spot'.Has a faint ring around it.Has 67 moons.

Saturn

Second largest planet in the Solar system. Its density is less than the water.Has a band of concentric rings revolving around it made up of tiny rocks and pieces of ice. Has 62 moons. Moons of Saturn: Titan is the largest

Uranus

Discovered by Sir William Herschel. Blue-green (cyan) in colour. Third biggest planet of the solar system. Composed of Hydrogen, Helium, Water, Ammonia, Methane. It is tilted sideways so that its poles lie where most other planets have their equators. Has faint rings.

Neptune

Discovered by mathematical predictions and disturbances in Uranus' orbit. First proposed by Alexis Bouvard, and first observed by Johann Galle..Farthest planet from the Sun.Primarily composed of hydrogen, helium, nitrogen, water, ammonia, methane.Is blue in colour because of methane. Has a storm called 'Great Dark Spot'

Pluto

Used to be the ninth planet. Demoted to status of "Dwarf Planet". Icy and cold.

The four gas giants, Jupiter, Saturn, Uranus and Neptune, have rings.

What is a moon?

A moon is a natural satellite of a planet.

Mars has two small moons. Mercury and Venus have none. Our Moon is unusually large—about one-fourth the size of Earth. While it is in thrall to our gravitational pull, it is large enough to pull back. The Moon's gravity slows our rotation and creates our ocean tides.

What is a comet?

Comets are small, fragile, irregularly shaped bodies composed mostly of a mixture of water ice (ice composed of H_20), dust, and carbon- and silicon-based compounds

The solid core is called the nucleus, which develops a coma with one or more tails when a comet sweeps close to the Sun. The coma is the dusty, fuzzy cloud around the nucleus of a comet, and the tail extends from the comet and points away from the Sun. The coma and tails of a comet appear only when the comet is near the Sun.

Comet Halley, whose orbital period is 76 years – spend most of their time between Pluto and the Sun.

Asteroids

Are generally larger chunks of rock that come from the asteroid belt located between the orbits of Mars and Jupiter.

Cosmology: The study of the overall structure and evolution of the universe

Black hole

A black hole is a place in space where gravity pulls so much that even light can not get out. The gravity is so strong because matter has been squeezed into a tiny space. This can happen when a star is dying.

Because no light can get out, people can't see black holes. They are invisible. Space telescopes with special tools can help find black holes. The special tools can see how stars that are very close to black holes act differently than other stars.

Light-year

A light-year is a unit of distance. It is the distance that light can travel in one year. Light moves at a velocity of about 300,000 kilometers (km) each second. Which is 9.4607 × 10^{12} km (nearly 6 million million miles).

Hubble's law

The proportionality between the distance and the apparent recession velocities of galaxies is known as Hubble's law: v = H0 d, where H0 is called the Hubble constant, the ratio of the speed to the distance.

The Earth

Earth is the third nearest planet to the sun. It is the fifth largest planet in the solar system. The Earth's orbit lies between the orbits of Venus and Mars. It takes 23 hours 56 minutes and 4 seconds for the earth to complete one rotation on its own axis. The Earth takes 365.25 days to complete one revolution around the Sun. Earth's surface temperature varies from – 88q to 58qC and it is the densest planet in the solar system.

The Earth is a unique planet because of its distance from the sun, its motions, atmosphere with oxygen, presence of water and moderate temperature. The earth is neither too close nor too far from the sun. It is the only known planet to support life. It is also known as the 'Blue Planet' because of the presence of water. Earth has only one natural satellite called the Moon. The sun light takes about 8.3 minutes to reach the earth.

Shape and size of the Earth

It once was believed that the Earth was flat and that ships could sail over the edge. This view persisted even in the middle ages and was an issue in recruitment of Columbus.

Early Greek view was that the world was surrounded by the ocean (Oceanus), origin of all rivers. Anaximander (600 B.C) proposed that cylindrical earth was surrounded by celestial sphere. Pythagoras (582-507 B.C.) believed that the Earth was a sphere, which was considered the most harmonious geometric shape. Aristotle (384-322 B.C.) described observations that supported the theory that the Earth was a sphere. These included the fact that the shadow of the moon is circular in lunar eclipses and constellations were higher in the sky as one traveled south. Eratosthenes (275-195 BCE) estimated size of earth from observations that the elevation of the sun varied with position on the

Earth's surface in Egypt. Observations of the following suggested that the Earth is a sphere.

- Mountain peaks lit by the Sun after sunset.
- Ships disappear below the horizon as they sail across ocean.
- The moon looks like a disc.
- The Earth casts a circular shadow during lunar eclipses.

The Earth is an oblate spheroid, bulged at the equator and flattened at the poles. It is called 'Geoid' meaning the earth is earth-shaped. The bulge at the equator is caused by the centrifugal force of the Earth's rotation. The gravitational pull of the earth is the strongest at the flattened poles and it is weaker towards the equator.

The Sun's gravitational pull differs in force at the poles. The North Pole points in the same direction to the North Star when it revolves about the Sun. If the Earth would not have been tilted on its axis, the days and nights would have been of same duration always.

Formation of Continents and Oceans

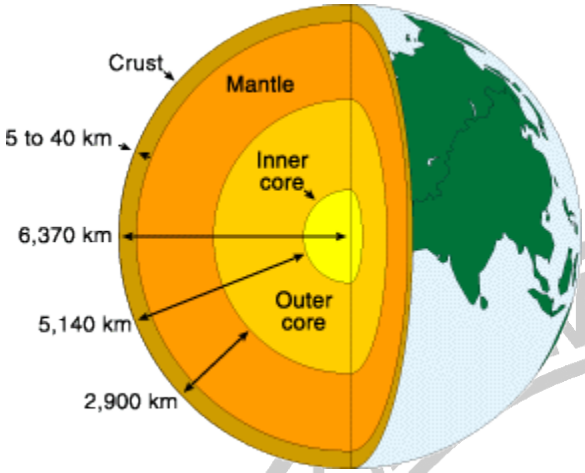
The land and water bodies were not always distributed on the surface of the earth as they are today. A few million years ago, all the present continents were clustered together around the South Pole. This Super continent was called Pangaea. In Greek, it means "all earth". The Pangea was surrounded by a Mega Ocean called the Panthalassa or the Super Ocean. In Greek, it means "all water". The Pangea was broken into a number of plates known as the lithosphere Plates. These Plates move around very slowly, from a few Millimeters to a centimeter a year.

The Pangea split into seven major plates and smaller plates. The major plates were the Eurasia, Antarctica, North America, South America, Pacific, Africa and IndoAustralian plates. The smaller plates include the Arabian, Caribbean, Philippine, Cocos, Nazca and so on. These plates are continuously in motion with respect to each other.

Interior of the Earth

By analyzing the seismograms recorded from many earthquakes, scientists have discovered that three main layers or shells exist within the Earth. Isaac Newton was one of the first scientists to theorize about the structure of the earth. Since then many scientists presented theories on the structure of the

earth. The part of the earth we live on is a very thin layer compared to the interior of the earth. The interior of the earth can be divided into three major layers based on chemical composition and characteristics. They are the crust, mantle and the core.



Crust

The uppermost layer of the earth's surface is called the "crust or lithosphere". The continental crust is composed of a layer called the "SIAL" which is made up of Silica and Aluminium. The oceanic crust is composed of basaltic layer called the "SIMA" which is made up of Silica and Magnesium. Crust is thicker on the continents and thinner on the ocean floors. The sial layer is floating on the sima layer. The average depth of sial is about 20 km and The average depth of sima is about 25 km. The average density of the crust is about 3 g/cm3

Mantle

Mantle lies between the crust and core. It comprises about 83% of the Earth's volume. It is made up of plates that move and create continental drift. Beyond 900 km, this layer is completely homogenous. Upper mantle is known as "Asthenosphere". It extends upto a depth of 700 km. Lower mantle is semisolid and is plastic in nature. The average density of the mantle is about 8g/am

Core

The inner most layer of the earth is called the "Core or Barysphere". It is otherwise known as NIFE, because of the presence of Nickel and Ferrous(iron). This layer produces earth's magnetic field. It has two main divisions; they are the outer core and the inner core. The particles present here resemble liquid. It may be in a solid state due to excessive pressure of the surrounding layers. The

density of the coreis about12g/cm2. The outer core and inner core are separated by Lehmann boundary

Temperature at Interior of the Earth

The experience of volcanic eruption, hot springs and mines indicate that heat increases as we move downwards into the earth. The temperature is estimated at the centre of the Earth to be as high as 5000°C.The normal temperature change is 1°C for every 32 metres of descent.

Forces of Earth Movements

The crust of the earth is not stable. Several areas of the present land masses were once beneath the sea. Continuous changes are taking place on the surface of the earth. In ancient geological part of the place where the Himalayas lies was occupied by the shallow Tethys sea. A few of the changes are gradual and slow, some of them are sudden. These changes are brought on by two different forces. They are, Endogenic and Exogenic forces.

Motions of the earth

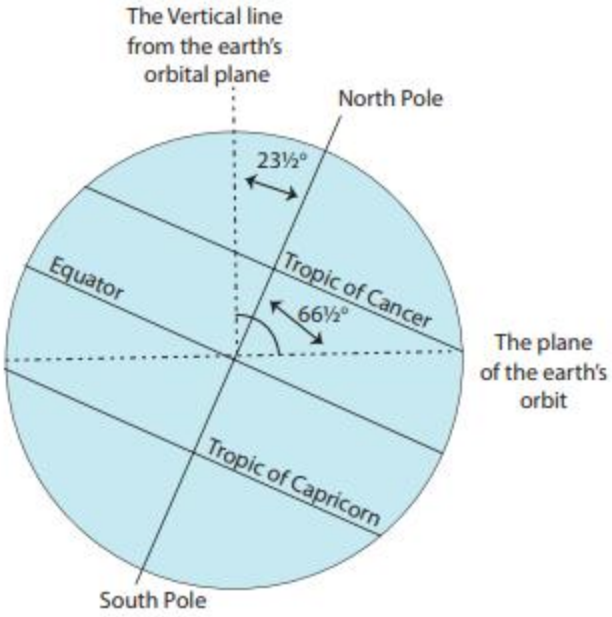
The earth has two basic movements:

1) Rotation and

2) Revolution.

Rotation:

The spinning of the earth around its axis is called the rotation of the earth. The axis is the imaginary line passing through the centre of the earth. The earth completes one rotation in 23 hours, 56 minutes and 4.09 seconds. It rotates in an eastward direction opposite to the apparent movement of the sun. The earth's axis is inclined at an angle of 66½q to the orbital plane as it moves around the sun. We can say, the earth's axis is tilted at an angle of 23½q from a perpendicular to the elliptic plane. The velocity of earth's rotation varies depending on the distance of a given place from the equator.The rotational velocity at the poles is nearly zero. The greatest velocity of the rotation is found at the equator. The velocity of rotation at the equator is 1,670 km per hour.



Effects of earth's rotation:

- The apparent rising and setting of the sun is actually caused by the earth's rotation which results in the alternate occurrence of day and night everywhere on the earth's surface
- Rotation of the earth is also responsible for the difference in time between different places on the earth. A 24 hour period divided by 360 degrees gives a difference of 4 minutes for every degree of longitude that passes the sun. The hour (60 minutes) is thus 1/24 of a day
- When you observe through a moving train, trees, houses and fields on the other side of the track appear to move in the direction opposite to that of the speeding train. The apparent movement of the sun and the other heavenly bodies in relation to the rotating earth is similar. As the earth rotates from west to east, the sun, moon, planets and stars appear to rise in the east and set in the west
- Rotation causes the working of the Coriolis force which results in the deflection of the winds and the ocean currents from their normal path.
- Tide is caused by the rotation of the earth apart from the gravitational pull of the sun and the moon

Rotation causes a flattening of Earth at the two poles and bulging at the Equator. Hence, there is a difference in diameter at the poles and equator.

Circle of Illumination: The line around the earth separating the light and dark is known as the circle of illumination It passes through the poles and allows the entire earth to have an equal amount of time during the daylight and night time hours. This line can be seen from space, and the exact location of the line is dependent on the various seasons.

Revolution of the Earth

The movement of the earth in its orbit around the sun in an anti-clockwise direction, that is, from west to east is called revolution of the earth. The earth revolves in an orbit at an average distance of 150 million km. The distance of the earth from sun varies time to time due to the elliptical shape of the orbit. About January 3rd the earth is closest to the sun and it is said to be at Perihelion ('peri' means close to and Helios means sun). At Perihelion, the distance is 147 million km.

Around July 4th the earth is farthest from the sun and it is said to be at Aphelion (Ap means away and Helios means sun). At Aphelion the distance of the earth is 152 million km away from the sun.

The period taken by the earth to complete one revolution around the sun is 365 days and 6 hours (5 hours, 48 minutes and 45 seconds) or 365¼ days. The speed of the revolution is 1,07,000 km per hour. The speed is 30 km per second. The bullet from a gun travels with a speed of 9 km per second.

Period of Revolution and Leap year

The period of time the earth takes to make one revolution around the sun determines the length of one year. The earth takes 365 days and 6 hours to complete one revolution. Earth takes 365.25 days to complete one trip around the Sun .That extra quarter of a day presents a challenge to our calendar system, which has one year as 365 days. To keep our yearly calendars consistent with our orbit around the Sun once in, every four years we add one day.

The extra day added to is called a leap day, and the year the extra day is added to is called a leap year. The extra day is added to the month of February which has 29 days in a leap year.

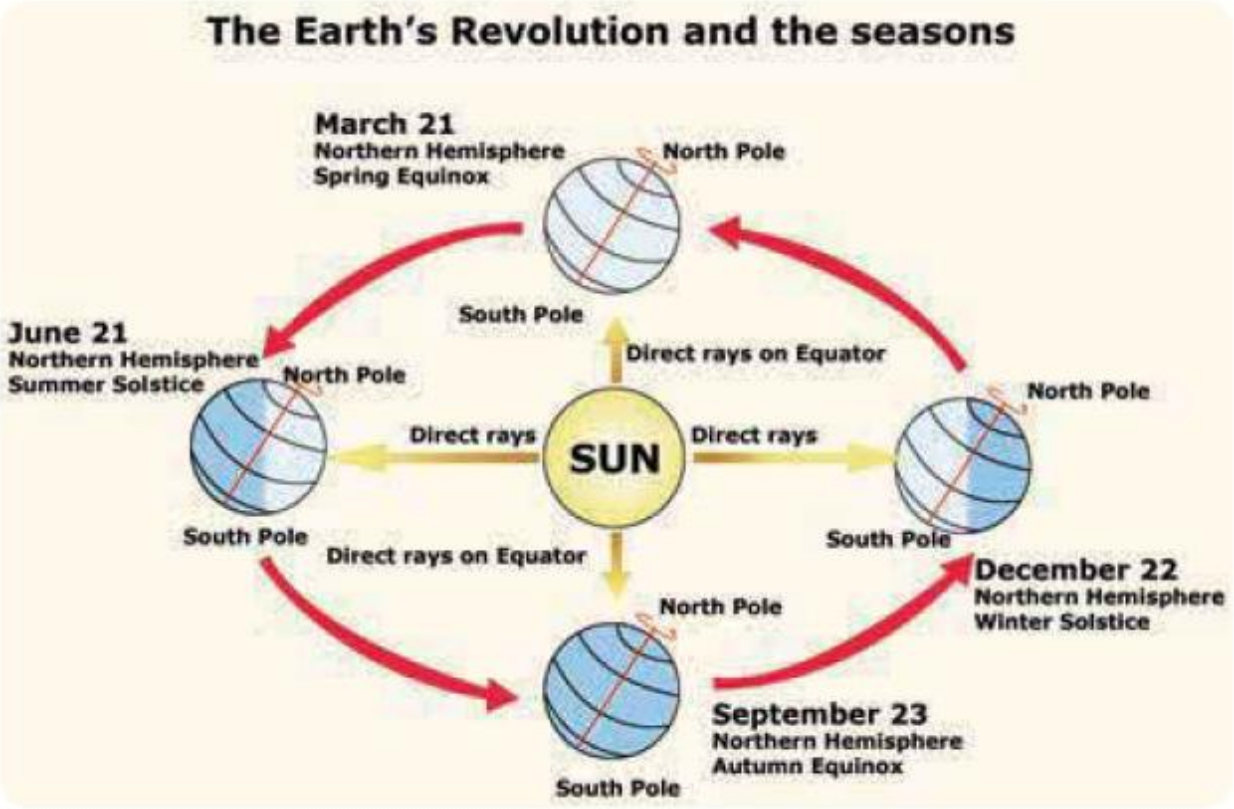
Effects of revolution of the earth

The revolution of the earth around the sun results in the following •

- Cycle of seasons,
- Variation in length of days and nights,
- Variation in distribution of solar energy over the earth and the temperature zones.

Seasons

The seasons are caused due to the combined effect of the earth's revolution and the tilt of its axis in the same direction throughout the year. In general, spring, summer, autumn and winter are the four seasons The latitude at which the sun appears directly overhead changes as the earth orbits the sun. The sun appears to follow a yearly pattern of northward and southward motion in the sky, known as the 'apparent movement of the sun'. It gives an impression that the sun is continuously swinging north and south of the equator. Actually it is the earth that is moving around the sun on its tilted axis. It varies when observed on a daily and monthly basis, at different times of the year. On 21 March and 23 September the sun rises precisely in the east and sets exactly in the west.



Equinoxes and solstices

Equinoxes

Equinoxes occur when the earth reaches the points in its orbits where the equatorial and the orbital planes intersect, causing the sun to appear directly overhead at the equator. During the equinoxes the periods of day light and darkness are equal all over the world. On 21 March the sun is directly overhead at the equator. Throughout the world, on this day all the places experience almost equal hours of day and night. This position of the sun is called spring equinox. Again on 23 September the sun is directly overhead on the equator and it is called autumn equinox

Position of the earth on 21 March Neither pole is inclined towards the sun. The rays of the sun fall vertically on the equator. All the places have equal days and nights as both the poles receive the rays of the sun. It is spring in the northern hemisphere and autumn in the southern hemisphere. This day (21 March) is known as spring equinox.

Position of the earth on 23 September. Neither pole of the earth is inclined towards the sun. The rays of the sun fall vertically on the equator. All the

places have equal days and nights. It is autumn in the northern hemisphere and spring in the southern hemisphere. This day (23 September) when sun's rays for fall verticaly on the equator, is known as autumnal equinox

Position of the earth on 21 June The North Pole is inclined or tilted towards the sun. It, therefore, experiences complete light for 24 hours. The South Pole is tilted away from the sun so it is in complete darkness for 24 hours. The rays of the sun fall vertically at the tropic of cancer (23½° N). In the Northern hemisphere, the days are longer than the nights .It is summer in the northern hemisphere and winter in the southern hemisphere. The day 21 June is known as summer solstice.

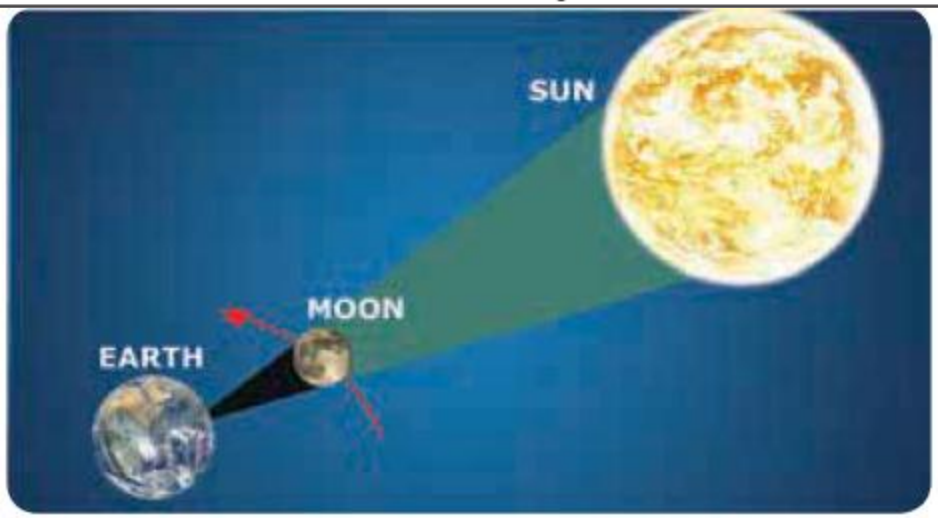
Position of the earth on 22 December The South Pole is inclined towards the sun and the North Pole is away from it. The rays of the sun fall vertically at the tropic of Capricorn (23½° S). The greater part of the southern hemisphere gets the direct rays of the sun so the days are long and the nights are short here. In the northern hemisphere the nights are longer than the days at this time. The southern hemisphere has summer. The northern hemisphere has winter. This day (22 December), when the sun's rays fall vertically on the Tropic of Capricorn, is known as winter solstice.

Eclipses

Let us understand the effect of the revolution of the earth on the length of the days and the nights. The duration of the daylight varies with latitude and seasons. An eclipse is a complete or partial obscuration of light from a celestial body and it passes through the shadow of another celestial body. The eclipses are of two types.

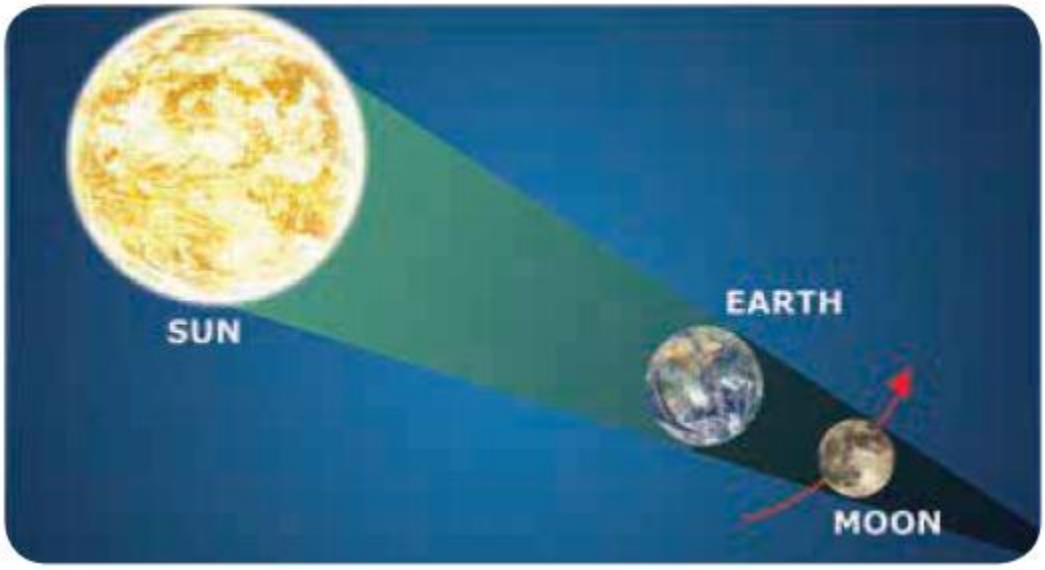
Solar Eclipse

It occurs on New Moon days, when the moon is between the Sun and the Earth. Thus it obscures a part of the Sun viewed from the Earth, but only from a small area of the world. It lasts only for a few minutes. A partial solar eclipse happens when the moon partially covers the disc of the sun. An annular solar eclipse occurs when the moon passes centrally across the solar disc. During a total solar eclipse, the moon's shadow is short enough to cover the whole sun. The outer regions still glow and look bright as a ring. Such a phenomenon is called Diamond Ring.



Lunar Eclipse

It occurs on a Full Moon position when the earth is between the sun and the moon. The earth's shadow obscures the moon as viewed from the earth. A partial lunar eclipse can be observed when only a part of the moon's surface is obscured by earth's umbra. A penumbral lunar eclipse happens when the moon travels through the faint penumbral portion of the earth's shadow. A total lunar eclipse occurs when the earth umbra obscures the entire the moon's surface. Lunar eclipse can be seen from anywhere on the night side of the Earth. It lasts for a few hours due to the smaller size of the moon.

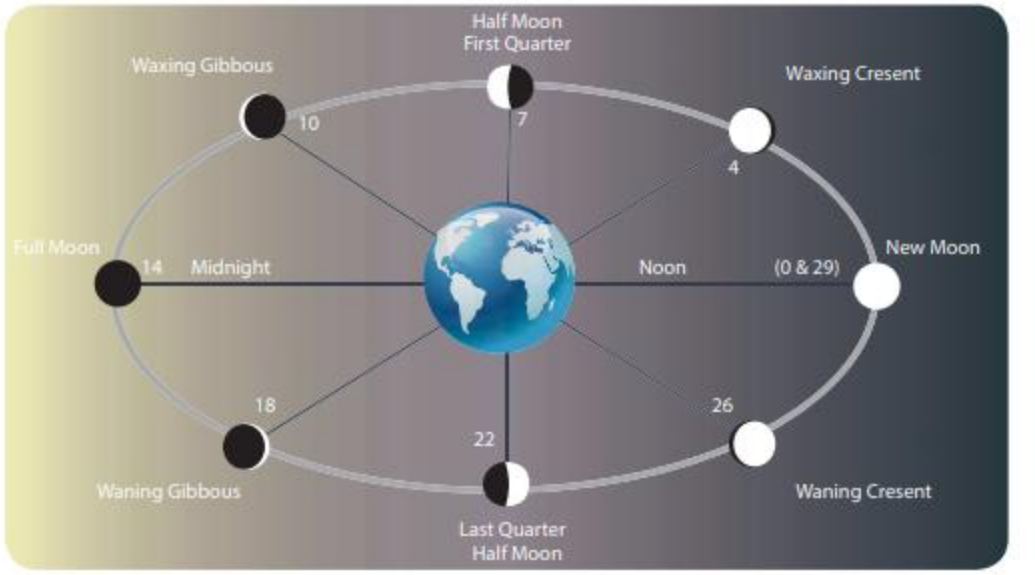


Phases of the Moon

The changing angles between the earth, the sun and the moon determine the phases of the moon. Phases of the moon start from the 'New Moon' every month. Then, only a part of the Moon is seen bright called 'Crescent', which develops into the 'first quarter'. With the increasing brightness it turns into three quarters known as 'Gibbous' and then it becomes a 'Full Moon'. These stages are the waxing moon. After the full moon, the moon starts waning or receding through the stages of Gibbous, last quarter, crescent, and finally becomes invisible as dark New Moon

The varying lengths of daylight in different latitudes

It is evident from the table that the duration of daylight is 12 hours throughout the year at the equator only. As one moves away from the equator, the seasonal variations in the duration of daylight increase. The seasonal variations in the duration of daylight are maximum at the polar region.



Phases of Moon

Effects of the spherical shape of the earth

Variation in the amount of solar radiation received: If the earth were a flat surface, oriented at right angle to the sun, all the places on the earth would have received the same amount of radiation. But the earth is spherical/ geoid. Hence the sunrays do not heat the higher latitudes of the earth as much as the tropics. On any given day only the places located at particular latitude receive vertical rays from the sun. As we move north or south of this location, the sun's rays strike at decreasing angles. The yearly fluctuations in the angle of

the sun's rays and the length of the days change with the continual change of the earth's position in its orbit around the sun at an inclination of 66½ to the orbital plane.

Difference in the angle of the sun's rays striking different parts of the earth.

Away from the equator, the sun's rays strike the earth's surface at particular angle. The slanting rays are spread over a large area and do not heat with the same intensity as the direct rays. As we go pole wards, the rays spread over the regions beyond the Arctic and the Antarctic circles in an extremely slanting manner. This is how we get the various temperature zones. Lower the degree of latitude; higher the temperature. Not only that, the rays striking at a low angle must travel through a greater thickness of the atmosphere than the rays striking at a higher angle. The rays striking at a lower angle are subject to greater depletion by reflection and absorption by the atmosphere.

Temperature zones

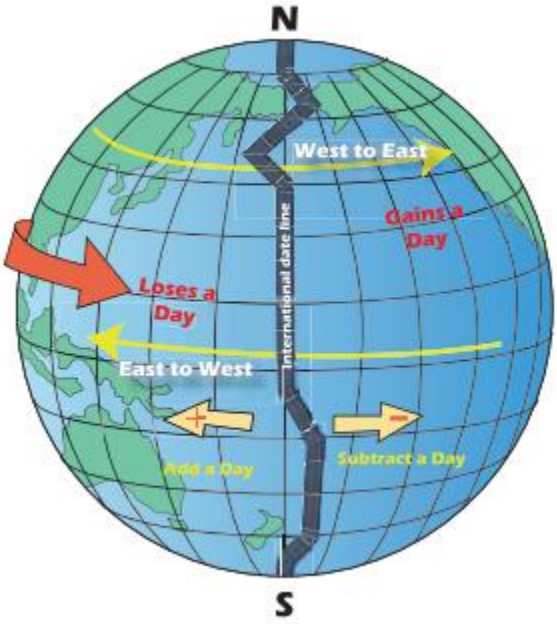
The spherical shape of the earth along with its movement around the sun causes differences in the angles at which the sun's rays fall on the earth's surface. This causes a difference in the distribution of heat on the earth's surface. As a result, the world has been divided into three distinct heat zones or temperature zones. They are the Torrid zone, Temperate zone and Frigid zone. You will learn more about it under the unit atmosphere.

Time Zones of the World

People during the medieval period were using sundials and water clocks to observe the Sun's meridian passing at noon. In 17th century, the people started using pendulum clock which did not show accurate time while travelling in the sea. Later chronometer was invented in 1764. Chronometer measures time accurately and the mariners widely used this during the 19th century. But in many towns and cities clocks were set based on sunset and sunrise. The use of local solar time hindered the development of railways and telecommunications. A time zone is a region on the earth where uniform standard time should be maintained for transport, commercial and social purposes. For example, if different time zones were followed, the trains coming from different regions, sharing single track may meet with accidents

The world time zone was formed, relating longitude and the rotation of the earth. The Prime Meridian is the centre of time zone extending from 7½°W and

7½ ° E longitudes. The 24 hours time zone system had been developed so that all the time zones should be referred with respect to Greenwich Mean Time. Earth was divided into 24 time zones, each one zone for one hour of the day. It is because earth rotates 15° of longitude in one hour (360° divided by 24 hours). The time when solar noon occurs at the Prime Meridian is fixed as noon for all places between 7½° E and 7½° W.



Daylight Saving Time

In the mid latitude countries of Europe, North America, Australia and South America, the day time are longer in summer than the night. In spite of employing daylight duration, the clocks are adjusted 1 hour forward in spring and 1 hour backward in autumn. This time is generally known as 'the Daylight Saving Time' (DST).

Time Zones

On its axis, the earth rotates 360 degrees every 24 hours. You can look at it as it takes one day to complete a full circle. Divided up into an hourly rate, the earth rotates 15 degrees every hour (360/24). This number plays an important role in determining time zones.

An important factor in determining time zones is the lines of latitude and longitude, imaginary lines known as latitudes and longitudes dividing the earth.

Latitude lines

Latitude lines are drawn east - west and they measure the location in northern and southern hemisphere. The line starts at the equator and measure distance from 0 degrees to 90 degrees north and also 0 degrees to 90 degrees south. They also become shorter farther away from the equator. On the other hand, longitude lines are drawn north - south and they measure eastern and western hemisphere. They start at the Prime Meridian (or 0 degree) and measure from 0 degrees to 180 degrees east and 180 degrees west. Unlike lines of latitude, these lines are fairly equal in length. The origin of this spherical coordinate system is at 0 degree latitude and 0 degree longitude. This spot can be found in the Atlantic Ocean just south west of Africa. Also, the two lines connect at 180 degrees or at the International Date Line .This too helps to determining different time zones of the world.

Latitudinal lines

Latitudinal lines are imaginary horizontal lines over the Earth's globe. 0q longitudinal line is Equator. Earth completes one rotation on its axis in 24 hours and in the process turns a complete circle of 360q. This means Earth rotates 360q/24 15q in one hour. Every gain or loss of 1q longitude stands for 4 minutes.

Earthquake

Earthquake is a sudden shaking of the earth's surface. Focus is the location inside the earth where the earthquake originates. Epicenter is the point on the earth's surface vertically above the focus of an earthquake. Earthquake results from the sudden release of pressure which has slowly built up within the earth's crust. Energy is released in the form of shockwaves known as seismic waves. The seismic waves can broadly be classified into two types namely Body waves and surface waves

Body

Waves are the waves that travel through the interior of the earth. They are further divided into the following

Primary waves

P or Primary or Compressional waves are the fastest seismic waves (6 km/ sec. in the upper crust). They cause the matter to oscillate forward and backward,

parallel to the motion of the seismic wave front. P waves push (compress) and pull (dilate) the rock that they pass through. They pass through all medium.

Secondary

S or Secondary or Shear waves are slower than the primary waves (3.5 km/sec. in the upper crust). They cause matter to oscillate side to side, perpendicular to the motion of the wave front. S waves shear the rock that they pass through. They pass through only solid medium

Surface Waves

Surface Waves are the waves that travel along the earth's surface. They are slower than body waves. They cause damage during earthquakes

Love waves shake the ground side to side like S wave.

Rayleigh waves displace the ground like rolling ocean waves. The ground rolls forward and up and then down and backwards. This is similar to a p wave but with the extra up-down motion.

Measuring the earthquake

It is estimated that about 100,000 earthquakes occur but all cannot be felt. A few earthquakes may be severe causing huge damage to property. Earthquake magnitude is measured on the Richter scale (named after the seismologist who devised it), which rates them on a scale of 1 to 10. Earthquake intensity is measured on the modified Mercalli scale, which ranges from 1 to 12, depending upon the intensity. The seismograph is an instrument used to detect and record seismic waves created by the earthquakes.

Causes of Earthquakes

There are many factors controlling the occurrence of the earthquake. Some of the major factors include:

- Plate Tectonic Movements
- Volcanic Eruptions.
- Construction of large dams results in earthquake. Example. Koyna dam, Maharashtra.
- Other Reasons: The nuclear explosions also release massive energy to cause tremors in the earth crust. When underground cave collapses, earthquake may occur.

Effects of the Earthquakes

- Damage to buildings, roads, rails, factories, dams, bridges etc.
- Landslides caused by earthquakes damage infrastructure.
- Fires in the forest and urban areas. 4
- Flash floods.
- Tsunami - The high amplitude oceanic waves caused by submarine earthquake (measuring more than 7 on Richter scale). The seismic waves travel through seawater generates high sea waves. They cause severe loss of life and property. For instance, on 26th December 2004, a tsunami originating from a magnitude 8.9 earthquake in northern Sumatra killed over 1,50,000 people in countries surrounding the Indian Ocean.

Distribution of earthquakes

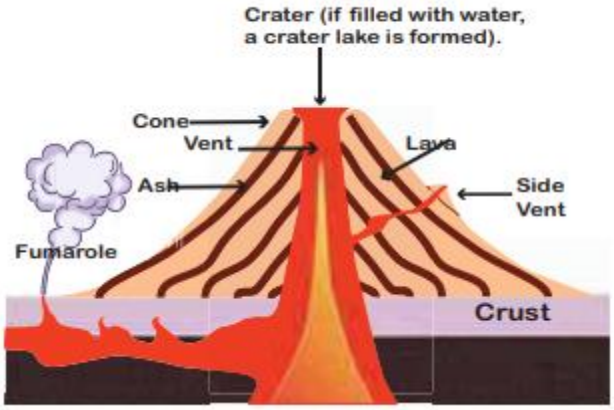
Circum-Pacific region: This region includes all the coastal areas around the Pacific Ocean. It extends through the coasts of Alaska, Aleutian Islands, Japan, Philippines, New Zealand, west coast of North and South America. This zone accounts for 68% of all earthquakes on the surface of the earth

Mediterranean-Himalayan region: This region extends from Alps mountain to the Himalayan Mountains and Tibet to China. About 31% of world's earthquakes occur in this region.

Other Areas: These include Northern Africa and Rift Valley areas of the Red Sea and the Dead Sea.

Volcano

A volcano is an opening in the earth's crust through which magma, gases and ash are released to the earth's surface. The molten rock material found in the interior of the earth is called magma. It can be noted that when magma reaches the earth's surface, it is known as lava .Vent is an opening or mouth of a volcano. Fumaroles are the gushing fumes through the gap in the volcano. Crater is a saucer shaped depression in the mouth of a volcano. When the crater is widened, it is called as Caldera. Volcanic ash consists of fragments of pulverized rock, minerals and volcanic glass, created during volcanic eruptions. Volcano generally erupts either through the vent (E.g. Mt. Fujiyama, Japan) or fissure (The Deccan Plateau, India).



Pumice is a volcanic rock produced when lava with a very high content of water and gases is discharged from a volcano.

Causes of Volcanic Eruptions

Weak Zones in the Earth Crust: The parts of the earth where two tectonic plates collide against or drift apart from each other are considered very weak. Volcanoes may erupt in such zones, for example, African and Eurasian plates.

Magma Saturated with Gases: The magma, in the interior of the earth, is often found saturated with gases like carbon dioxide, and hydrogen sulfide. These gases together with water vapour make the magma highly explosive. Magma is forced out as lava on the surface of the earth due to the pressure exerted by these gases.

Types of Volcanoes

Active Volcanoes: Volcanoes which erupt frequently are called active volcanoes. Generally, their vent remains open. Mount Etna of Italy, Cotopaxi in Ecuador are some examples.

Dormant Volcanoes: These volcanoes may not have erupted in the recent past but there is a possibility of eruption at any time. In other words, they may lie dormant awaiting active eruption anytime. Sometimes gases and steam come out of them. They cause great destruction to life and property once they become active again. Mt. Vesuvius of Italy and Mt. Fujiyama of Japan are examples.

Extinct Volcanoes: These volcanoes have exhausted their energy and have not erupted during the known geological period. The vent of these volcanoes

remains closed with solidified lava. The formations such as craters may be filled with water and crater lakes may be formed. The slopes of these landforms may be covered with vegetation. Popa in Myanmar and Mt. Kenya in eastern Africa are the examples of extinct volcano.

On the basis of nature of eruption and form developed on the surface, they are classified into following types:

Shield Volcanoes: These are made up of basalt, a type of lava that is very fluid when erupted. They become explosive when water gets into the vent. They develop into a cinder cone. Hawaiian volcano is an example of this category.

Composite cone volcanoes: They are also called 'strato volcanoes'. They are cone-shaped volcanoes composed of layers of lava, ash and rock debris. Mount Vesuvius and Mount St. Helens are examples of composite volcanoes.

Cinder Cone Volcano : It forms when magma is thrown out to the surface, cooled in to ash and cinders and settled around the mouth of volcano. It is less dangerous than other volcanoes.

Lava Dome: Unlike composite and shield volcanoes, lava domes are of significantly smaller structure. They are formed when the lava is too viscous to flow to a great distance. As the lava dome slowly grows, the outer surface cools and hardens as the lava continues to pile within. Eventually, the internal pressure can shatter the outer surface, causing loose fragments to spill down its sides.

Effects of Volcanic Activities

Destructive effects of volcano Showers of cinders and bombs can cause damage to life and properties. Sometimes ash can precipitate under the influence of rain and completely cover large areas. The volcanic gases pose potential hazard to people, animals; agriculture, while sulfur dioxide gas can lead to acid rain and air pollution.

Positive Effects of Volcanoes

Volcanism creates new landforms. Volcanic rocks yield very fertile soil upon weathering and decomposition. The Kimberlite rock of South Africa, the source of diamonds, is the pipe of an ancient volcano. In the vicinity of active volcanoes, waters in the depth are heated from contact with hot magma giving rise to springs and geysers. The Puga valley in Ladakh region and Manikaran

(Himachal Pradesh) are promising spots in India for the generation of geothermal electricity.

Distribution of Volcanoes across the World

Pacific Ring of Fire Circum-Pacific region, popularly termed the 'Pacific Ring of Fire', has the greatest concentration of active volcanoes. Volcanic belt and earthquake belt closely overlap along the 'Pacific Ring of Fire'. It is estimated to include two-thirds of the world's volcanoes.

Mid Atlantic Region The Mid Atlantic Region coasts has comparatively fewer active volcanoes but many dormant or extinct volcanoes, example. St. Helena, Cape Verde Islands and the Canary Islands. But the volcanoes of Iceland and the Azores are active

The Great Rift valley of Africa In Africa some volcanoes are found along the East African Rift Valley. Kilimanjaro and Mt. Kenya are extinct volcanoes. The only active volcano in West Africa is Mt. Cameroon

Mediterranean Region Volcanoes of the Mediterranean region are mainly associated with the Alpine folds. Example, Mt. Vesuvius, Mt. Stromboli (known as the Light House of the Mediterranean Sea).

Other Regions Elsewhere in the interiors of continents of Asia, North America and Europe active volcanoes are rare. There are no volcanoes in Australia.

Volcanoes in India

Volcanoes in India There are no volcanoes in the Himalayan region of India. However, Barren Island, lying 135 km north-east of Port Blair became active in 1991 and 1995. However, the other volcanic island in Indian Territory is Narcondam (Andaman and Nicobar Islands) It is probably extinct. Its crater wall has been completely destroyed.

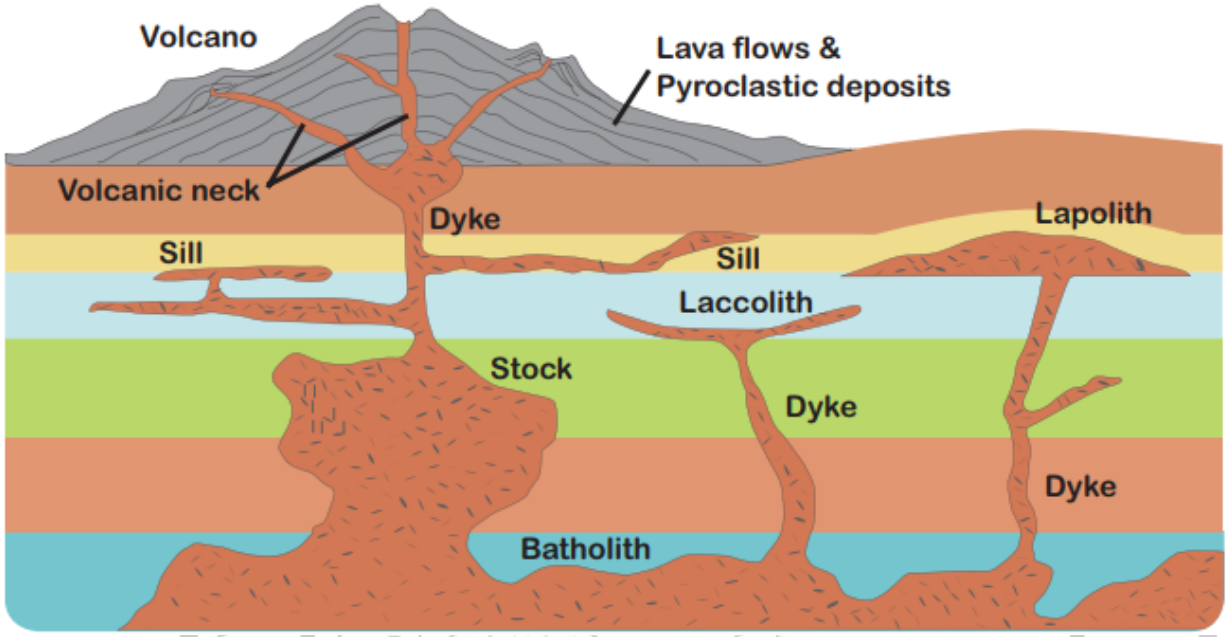
Rock Types

Igneous Rocks

Igneous rocks are formed out of magma and lava and they are known as primary rocks. If the magma cools slowly at great depths, mineral grains increase in their size. Sudden cooling (at the surface) results in small and smooth grains. The igneous rocks are the oldest of all the rocks. Granite, pegmatite, basalt, etc are some of the examples of igneous rocks. There are two

types of igneous rocks: intrusive rocks (Granite) and extrusive rocks (Basalt-Deccan Traps). Granite is less dense and is lighter in colour than basalt rocks.

Intrusive Igneous rocks



Intrusive Igneous rocks are formed when magma rises and cools within the crust. The intrusive activity of volcanoes gives rise to various forms. We see them one by one as follow.

Batholiths

Batholiths are large rock masses formed due to cooling and solidification of hot magma inside the earth. It is granitic in origin.

Laccoliths

Laccoliths are large dome-shaped intrusive rock connected by a pipe-like conduit from below. These are basically intrusive counterparts of an exposed domelike batholiths. The Karnataka plateau is spotted with dome hills of granite rocks. Most of these, now exfoliated, are examples of laccoliths.

Lapoliths When the magma moves upwards, a saucer shape, concave shaped body called Lapolith is formed.

Sill

Sill is a solidified sheet-like horizontal lava layer inside the earth. The near horizontal bodies of the intrusive igneous rocks are called sill or sheet, depending on the thickness of the material. The thinner ones are called sheets while the thick horizontal deposits are called sills.

Dyke

When the magma makes its way through cracks and the fissures developed in the land, it solidifies almost perpendicular to the ground. It gets cooled in the same position to develop a wall-like structure. Such structures are called dikes. These are the most commonly found intrusive forms in the western Maharashtra area. These are considered the feeders for the eruptions that led to the development of the Deccan traps.

Sedimentary Rocks

Sedimentary rocks are also called as detrital rocks. They are formed as a result of denudation. These deposits through compaction turn into sedimentary rocks. They occupy only 5 percent of the earth. They are layered or stratified of varying thickness. Example: sandstone, shale etc. Ice deposited sedimentary rocks is called Till. Wind-deposited sediments are called Loess.

Depending upon the mode of formation, sedimentary rocks are classified into

- **Mechanically formed sedimentary** rocks: sandstone, conglomerate, limestone, shale, loess, etc.
- **Organically formed sedimentary rocks**: geyserites, chalk, limestone, coal etc
- **Chemically formed**: halite, potash, etc.

Metamorphic Rocks

The word metamorphic means 'change of form'. The metamorphic rocks form under the action of pressure, volume and temperature (PVT) change. Metamorphism is a process by which the already consolidated rocks undergo recrystallisation and reorganization of materials within original rocks. Gneiss, slate, schist, diamond, marble, quartzite etc. are some examples of metamorphic rocks. The igneous and metamorphic rocks together account for 95 percent of the earth.

Rock Cycle

Rock cycle is a continuous process through which old rocks are transformed into new ones. Igneous rocks can be changed into sedimentary or metamorphic rocks. The fragments derived out of igneous and metamorphic rocks form into sedimentary rocks. Igneous and sedimentary rocks can change into metamorphic rocks. The crustal rocks (igneous, sedimentary and metamorphic) may be carried down into the mantle (interior of the earth) through subduction process and the same melt and turn into magma, the original source for igneous rocks. In this way the rock cycle is a continuous process.