Unit 2

The Solar system and the Earth

Chapter Outline

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2.1 Introduction

Have you ever relaxed lying on the terrace of a building or in the front yard at a cloudless night? If yes, could you watch the night sky filled with glittering stars which appear to be growing in numbers?

Learning Objectives:

- *To know more about the universe, stars, planets and others.*
- *Understand theories of the origin of the Universe.*
- *Explain the position of the planets in the solar system.*
- *Describe the cause and effect of the motions of the earth.*

These glittering stars, which we see, are a part of the universe. Let us now discuss in detail about the Universe, stars, planets and other objects. **The Universe** is a vast endless space which includes galaxies, stars, planets and other forms of matter and energy in it.

2.2 Theories of the Earth's origin

There are many theories supporting the origin of the earth. One of the earlier and popular arguments of the earth's origin was by a German professor Immanuel Kant. Mathematician Laplace revised it in 1796. It was known as Nebular Hypothesis. It considered that planets were formed out of a cloud of material associated with a youthful sun, which was slowly rotating. Lyttleton propounded the accretion theory of the earth's formation. According to this theory, approximately 4.6 billion years ago, the solar system was a cloud of dust and gas known as a solar nebula. As the solar nebula began to spin, the gravity collapsed the materials on itself and it formed the sun in the centre of the solar system. When the sun formed, the remaining materials began to clump up. Small particles drew together, bound by the force of gravity, into larger particles. The solar wind swept away lighter elements, such as hydrogen and helium, from the closer regions. It left only heavy rocky materials to create planets like the Earth. But farther away, the solar winds had less impact on lighter elements, allowing them to coalesce into gas giants. In this way, planets, moons, asteroids, comets, etc., were created.

DO YOU KNOW?

Voyager 2 travelling at the speed of more than 62,764.416 km/h will still take more than 296,000 years to pass Sirius, the brightest star in our night sky.

Earth's rocky core formed first when heavy elements collided and bound together. Dense materials sank to the center, while the lighter material created the crust. The planet's magnetic field probably formed around this time. Gravity captured some of the gases that made up the planet's early atmosphere.

2.3 Modern theories of the origin of the Universe

The most popular argument regarding the origin of the universe is **the Big Bang Theory**. It is also called expanding universe hypothesis. In 1927, Abbe Georges Lemaitre, a Belgian astronomer was the first to propose, a theory on the origin of the universe. It was Edwin Hubble who provided the evidence that the universe is expanding. It was called, **'the Big Bang Theory'**. According to it, the universe was formed during a period of inflation that began about **13.75 billion years** ago.

Like a rapidly expanding balloon, it swelled from a size smaller than an electron to nearly its current size within a fraction of a second. Matter from the universe was thrown out with great force in all directions and started expanding outwards. From this matter, many groups of stars were formed which we call 'galaxies'. 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 (Figure 2.1). The **Milky Way** is the galaxy that contains our Solar System.

Galaxies are in three major forms:

1. ***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.
2. ***Elliptical Galaxies:*** It contains older stars with fewer gases. Messier89 galaxy is an elliptical galaxy.

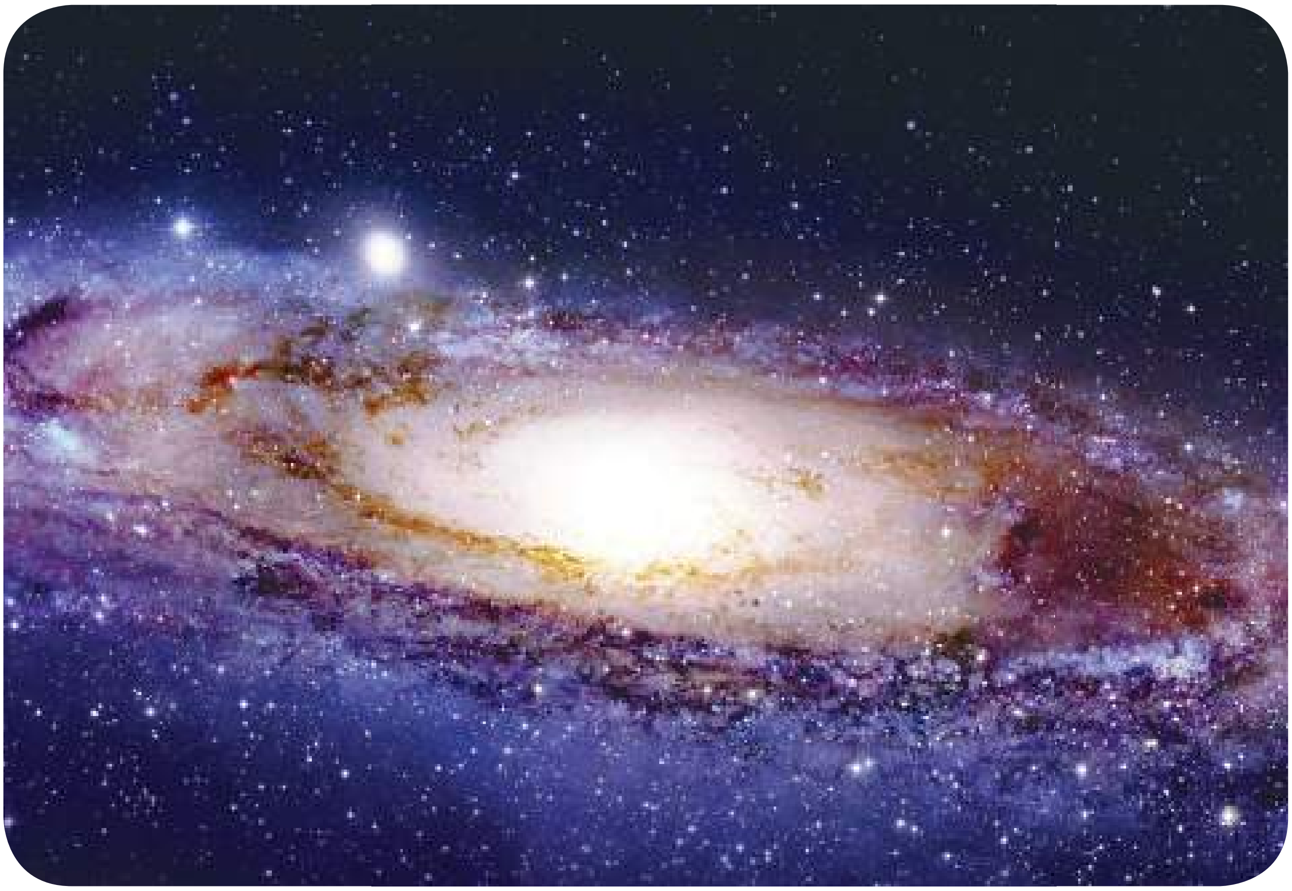

Figure 2.1 Milky Way Galaxy

3. ***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.

Initially, the universe was saturated only by energy. Some of this energy set into particles, which assembled into light atoms like hydrogen and helium. These atoms grouped first into galaxies, then stars and all the other elements. This is generally agreed-upon concept of our universe's origin as estimated by scientists.

In fact, the stars, planets and galaxies that can be detected make up only **4 percent** of the universe, according to astronomers. The other **96 percent** of the substances in the universe cannot be seen or easily understandable.

The new measurement technique called **gravitational lensing** confirmed the age of the universe and the strength of dark energy. Dark energy is responsible for the accelerating expansion of the universe. Scientists used gravitational lensing to measure the distances light traveled from a bright, active galaxy to the earth and some details of its expansion.

DO YOU KNOW?

Three scientists, Saul Perlmutter, Brian Schmidt and Adam Riess won the Nobel Prize in Physics (2011) for their discovery that the universe is just expanding and picking up speed.

2.4 Star and Constellations

A **star** is type of astronomical object which has its own light and heat. The nearest **star** to earth is the Sun. Sirius is brighter star than the sun. 'Proxima Centauri' is the closest star to the sun. Star is formed when enough dust and gas clump together because of the gravitational forces. Star changes its forms during its lifetime such as-red giant, white dwarf, neutron star and black hole.

Constellation (Figure 2.2) is a group of stars that forms a particular shape in the sky. In 1929, the International Astronomical Union (IAU) adopted official constellation boundaries that defined 88 official constellations that

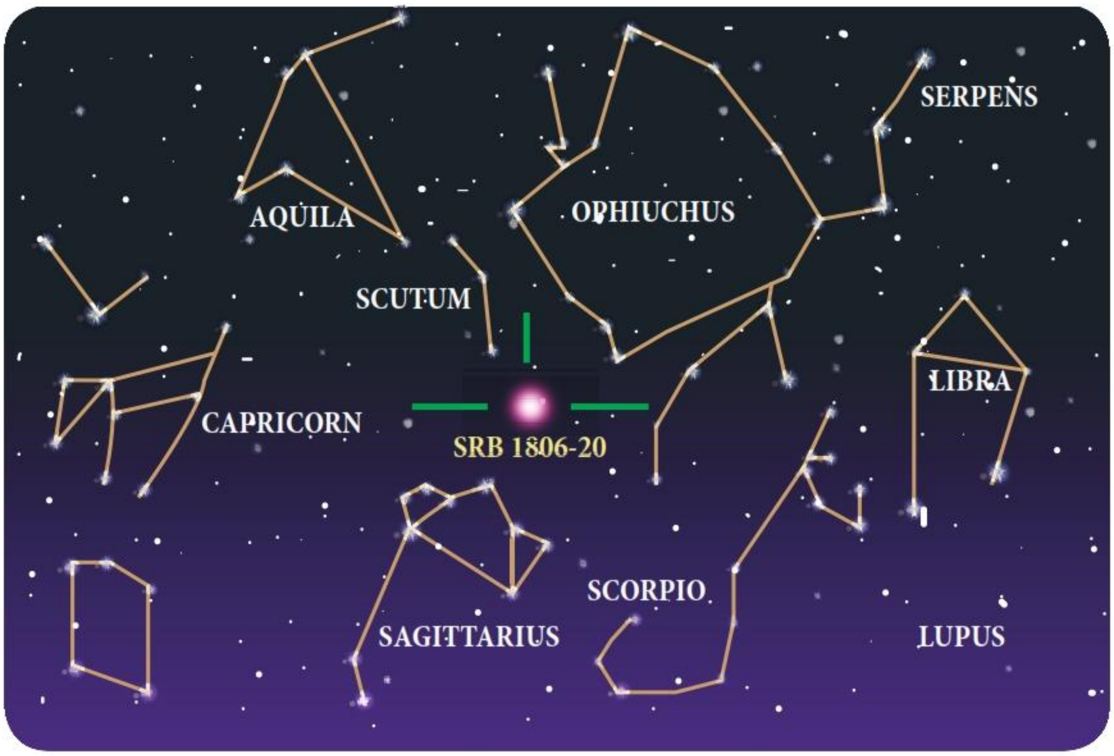

Figure 2.2 Constellation-Sagittarius, like a teapot

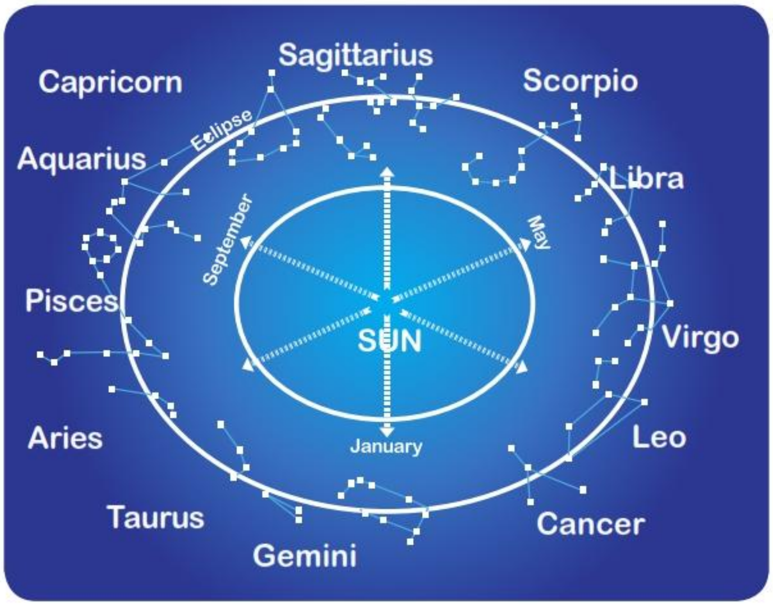

Figure 2.3 Constellation

Figure 2.4 Stars

exist today. Earlier Ptolemy, in his book *Almagest*, listed 48 constellations.

Ursa Major (Figure 2.3) is a constellation that can be seen in the northern hemisphere and part of the southern hemisphere. **Ursa Major** means **Great Bear** in Latin.

2.5 The Solar system

A solar system consists of a star (Figure 2.4) at the centre and the eight planets, moons, asteroids, comets and meteoroids that revolve it. The eight planets, namely the Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune, revolve around the sun in fixed elliptical paths known as '**orbits**'. Most stars host their own planets. So there are billions of other solar systems in the Milky Way galaxy alone.

Solar systems can also have more than one star. These are called binary star systems. If there are two stars or multi-star systems, if there are three or more stars. Our solar system is located in an outer spiral arm of the vast Milky Way galaxy. Our solar system orbits the centre of the Milky Way Galaxy at about 828,000 km/hr. Our solar system takes about 230 million years to complete one orbit around the galactic centre.

The solar system is believed to have been formed about 4.6 billion years ago. The solar system also includes the Kuiper Belt that lies past Neptune's orbit. This is a sparsely occupied ring of icy bodies. This is almost all smaller than the dwarf planet Pluto. Beyond the fringes of the Kuiper belt (Figure 2.5) is the Oort cloud. This giant spherical shell surrounds our solar system. It has never been directly observed,

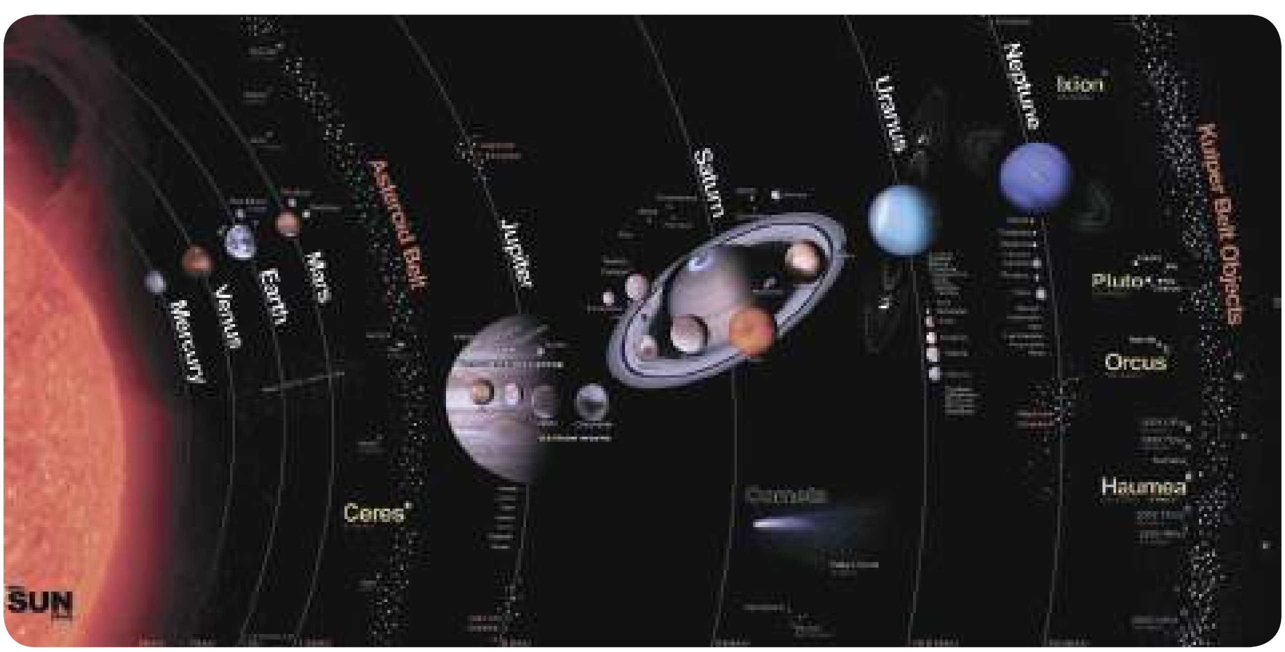

Figure 2.5 Solar system

but its existence is predicted based on mathematical models and observations of comets that likely originate there.

The Oort cloud is made up of icy pieces of space debris. It is orbiting our Sun as far as 1.6 light years away. This shell of material is thick, extending from 5,000 astronomical units to 100,000 astronomical units. One Astronomical Unit (AU) is the distance from the Sun to Earth, or about 150 million kilometre. The Oort cloud is the boundary of the Sun's gravitational influence, where orbiting objects can turn around and return closer to our Sun.

There are more than 163 known natural satellites in our solar system and several more awaiting confirmation of discovery. Of the eight planets, Mercury and Venus are the only planets with no satellites while the Jupiter and Saturn have the highest number of satellites in our solar system.

2.6 The Sun

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The Sun is at the centre of our solar system. It is a yellow dwarf star, with a hot ball of glowing gases. Its gravity holds the solar system together and it keeps everything from the biggest planets to the smallest particles of debris in its orbit. Electric currents in the Sun generate a magnetic field that is carried out through the solar system by the solar wind.

Structure of the Sun

By mass, the Sun is made up of about 70.6% hydrogen, 27.4% helium and 2% other gases. The Sun's enormous mass is

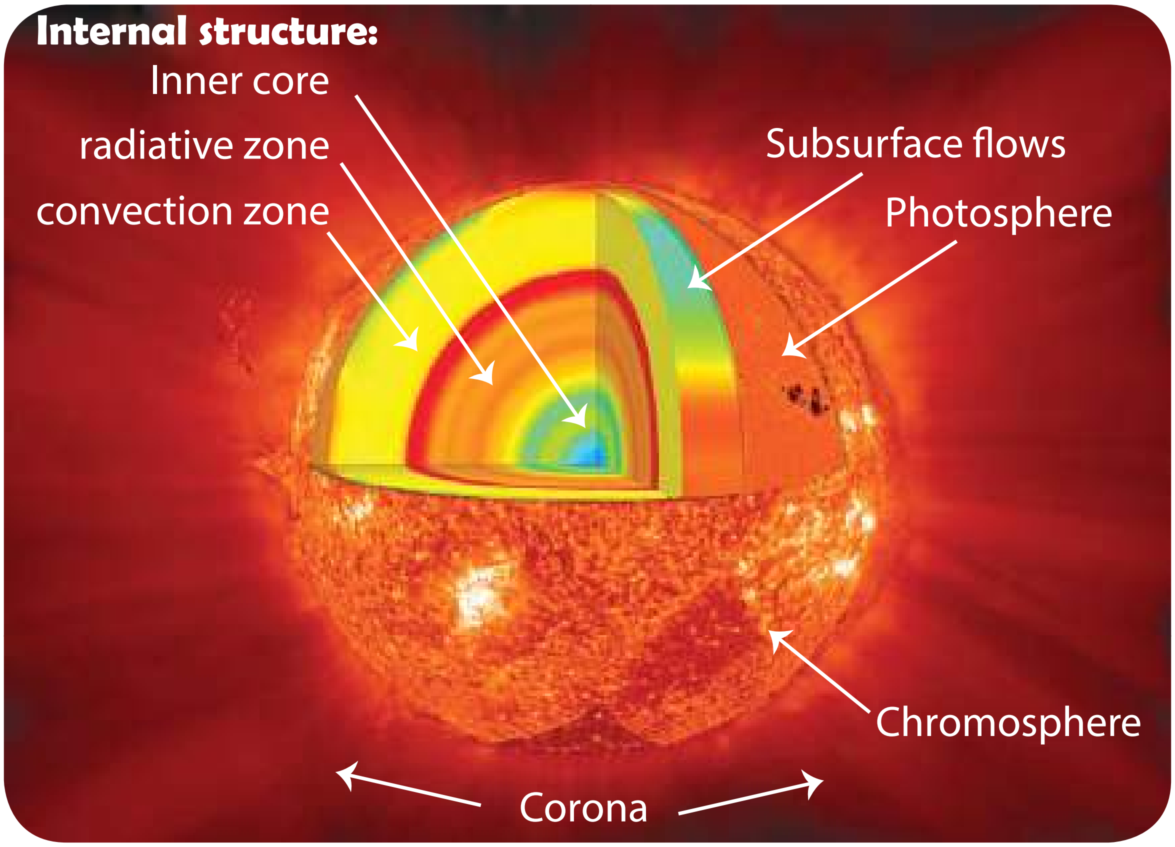

Figure 2.6 Structure of the sun

held together by gravitational attraction, producing immense pressure and temperature at its core. There are three main layers in the Sun's interior: the core, the radiative zone, and the convective zone (Figure 2.6). The core is at the centre. It is the hottest region, where the nuclear fusion reaction to give the sun power. Moving outward next come the radiative (or radiation) zone. Its name is derived from the way energy is carried outward through this layer, carried by photons as thermal radiation. The third and final region of the solar interior is named the convective (or convection) zone. It is also named after the dominant mode of energy flow in this layer. The boundary between the Sun's interior and the solar atmosphere is called the Photosphere. It is what we see as the visible 'surface' of the Sun.

Did you know that the Sun has an atmosphere? The lower region of the solar atmosphere is called the Chromosphere. Its name is derived from the Greek word *chroma* (meaning colour), for it appears bright red when viewed during a solar eclipse. A thin transition region, where temperature rises sharply, separates the chromospheres from the vast corona above. The uppermost portion of the Sun's atmosphere is called the corona, and is surprisingly much hotter than the Sun's surface (photosphere). The upper corona gradually turns into the solar wind. Solar wind is a flow of plasma that moves outward through our solar system into interstellar space.

Therefore, the Sun has six regions: the core, the radioactive zone, and the convective zone in the interior; the photosphere; the chromospheres; and the corona. The temperature of the sun's surface is about 5,500°c to 6,000 °c

At the core, the temperature is about 15 million°C, which is sufficient to sustain thermonuclear fusion. This is a process in which atoms combine to form larger atoms and in this process, released staggering amounts of energy. Specifically, in the Sun's core, hydrogen atoms fuse to make helium.

Size and Distance

The sun has a radius of 695,508 kilometres. It is far more massive than earth and 3,32,946 Earths equal to the mass of the Sun. The Sun's volume would need 1.3 million Earths to fill it.

DO YOU KNOW?

Venus is hotter than **Mercury** because **Venus** has an atmosphere which is thicker and made almost entirely of carbon dioxide.

Orbit and Rotation

The **Milky Way** has four main spiral **arms**: the Norma and Cygnus **arm**, Sagittarius, Scutum-Crux, and Perseus. The Sun is located in a minor arm, the Sagittarius arm. From there, the Sun orbits the centre of the Milky Way Galaxy, bringing the planets, asteroids, comets and other objects along with it. Our solar system is moving with an average velocity of 828,000 kilometres per hour. It takes about 230 million years to make one complete orbit around the Milky Way. The Sun's spin has an axial tilt of 7.25 degrees with respect to the plane of the planets' orbits. Since the Sun is not a solid body, different parts of the Sun rotate at different rates. At the equator, the Sun spins around once about every 25 days, but at its poles the Sun rotates once on its axis every 36 Earth days. Most of the materials are pulled toward the centre to form our Sun. The Sun alone accounts for 99.8% of the mass of the entire solar system.

Like all stars, the Sun will someday run out of energy. When the Sun starts to die, it will swell so big that it will engulf Mercury and Venus and maybe even Earth. Scientists predict that the Sun is a little less than halfway through its lifetime and will last another 6.5 billion years before it shrinks down to be a white dwarf.

2.7 The Planets

The word planet in Greek means 'wanderer'. Planet is the celestial body which does not have light or heat of its own. A planet should possess the following qualities:

a. It should orbit around the sun.
b. It should not be a satellite of any planet
c. Due to its own mass and self-gravity, it should get a spherical shape and
d. Any other celestial body should not cross in its orbit.

The planets are classified in order of their distance from the sun and based on their characteristics. They are:

1. **The inner planets** or terrestrial planets or rocky planets. Mercury, Venus, Earth and Mars are called inner or terrestrial planets.
2. **The outer planets** or gaseous planets or giant planets. Jupiter, Saturn, Uranus and Neptune are called outer or gaseous planets.

Each planet spins on its own axis. This movement is called rotation. One rotation makes one 'planet day'. The planets moving around the sun is called revolution or a 'planet-year'.

Planets in the Solar System

The Mercury

Mercury is the nearest planet to the sun and it is the smallest planet in the solar system. It does not have any satellite. It rotates on its own axis in 58.65 earth days while it takes 88 Earth days to complete one revolution around the sun. Mercury is 0.4 astronomical units away from the Sun. The sunlight takes 3.2 minutes to travel from the Sun to Mercury. Mercury is the second hottest planet though it is nearest to the sun.

The Venus

'Venus' is the second nearest planet to the sun. It is also called as **'Earth's Sister'** planet due to its similar size and mass as that of our Earth. It is the hottest planet in the solar system and experiences a mean surface temperature of 462°C. It is popularly known as **"Morning star and Evening star"** It is seen in the east sky before sunrise (dawn) in the morning and in the west sky after the sunset (twilight). It rotates clockwise i.e. east to west direction on its own axis. The rotation and orbit of the Venus are unusual in several ways. Venus is one of just two planets that rotate from east to west. Only Venus and Uranus have this 'backwards' rotation. It completes one rotation in 243 Earth days which is the longest day of any planet in our solar system. The Venus takes 224.7 Earth days to complete one revolution around the sun, and it has no natural satellites. Venus is 0.7 astronomical units away from the sun. The sunlight takes 6 minutes to travel from the sun to Venus.

Table 2.1 Distance of the planets from the sun

Name Of The Planet	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Diameter (km)	4,879	12,104	12,756	6,794	1,42,984	1,20,536	51,118	49,528
Density (kg/m3)	5,427	5,243	5,514	3,933	1,326	687	1,271	1,638
Rotation Period (hours)	1,407.6	5,832.5	23.9	24.6	9.9	10.7	17.2	16.1
Length of Day (hours)	4,222.6	2,802	24	24.7	9.9	10.7	17.2	16.1
The Average distance from the sun(10^6 km)	57.9	108.2	149.6	227.9	778.6	1,433.5	2,872.5	4,495.1
Orbital Period (days)	88	224.7	365.3	687	4331	10,747	30,589	59,800
Number of Satellites	0	0	1	2	67	53	27	13

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 (Table 2.1) to complete one revolution around the Sun. Earth's surface temperature varies from – 88°C to 58°C 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 8.2 minutes to reach the earth.

The Mars

Mars is the fourth nearest planet to the sun and it is the second smallest planet in the Solar system. It is also described as the **"Red planet"**. It is reddish in colour due to the presence of iron oxide on its surface. The landmass of Mars and Earth are very similar. It takes 24 hours and 37 minutes to complete one rotation on its axis and its takes 687 days to complete one revolution around the Sun. The surface temperature of the Mars is ranging from -153°C to 20°C. With the exception of the Earth, Mars probably is the most hospitable to life. This planet has seasons, polar ice caps, volcanoes, canyons and weather. Mars has two satellites namely Phobos and Deimos.

The Jupiter

Jupiter is the largest planet in the solar system. It is fifth planet from the sun. It is made primarily of gases and is therefore known as **'Giant Gas planet'**. It takes 9 hours 55 minutes to complete one rotation on its axis and it takes 11.86 years to complete one revolution. Jupiter has the shortest day in the solar system. Jupiter has a faint ring system around it. They are mostly comprised of dust particles. Jupiter has 67 confirmed satellites orbiting the planet. Ganymede, the satellite of Jupiter, is the largest natural satellite in the solar system (even bigger than the planet Mercury).

The Saturn

Saturn is the sixth planet from the sun and the second largest planet in the solar system. Saturn is called as the **Ringed Planet**. It is because of large, beautiful and extensive ring systems that encircles the planet. These rings are mostly made from the chunks of ice and carbonaceous dust. **Saturn** is the only planet in our solar system whose average density is less than water.

The Saturn has 30 rings and 53confirmed natural satellites. The Saturn takes 10 hours 34 minutes to complete one rotation on its axis and it takes 29.4 years to complete one revolution around the sun.

The Uranus

Uranus is the seventh planet from the sun and it is not visible to the naked eye. Like Venus, Uranus also rotates on its axis from east to west. Uranus is inclined on its axis at an angle of 98 degrees. The planet is almost lying on its side as it goes around the sun. The sunlight, thus, is received mostly in the polar areas. Hydrogen, helium and methane are the major gases of its atmosphere. It is very cold due to its great distance from the sun. Uranus is named after the ancient Greek god of the sky. It has a dense atmosphere primarily consisting of methane, which lends it a bluish-green appearance. Uranus also has rings and twenty-seven satellites.

The Neptune

Neptune is the eighth planet from the sun. It takes 16 hours to complete one rotation on its own axis and it takes nearly 165 years to revolve around the sun. It has 13 natural satellites and 5 rings. It is the **coldest planet** in the Solar System because it is the farthest planet from the Sun. Neptune was the first planet located through mathematical calculations. Neptune is our solar system's windiest planet.

HOTS

Which planet may float on water and why?

2.8 Dwarf Planets

Dwarf planets are tiny planets in our solar system. Any celestial body orbiting around the sun, weighing for the self gravity and nearly be round in shape is called 'Dwarf Planet'. It should not be a satellite of any planet. They are five in number Ceres, Pluto, Heumea, Makemake and Eris. As Pluto has not cleared the neighbourhood around its orbit, it is officially demoted in 2006 from its ninth position as a planet.

2.9 Satellites

The word 'Satellite' means companion. The moon was the only known satellite in the Solar System until 1610. Today, there are 163 known satellites in the Solar System. The satellites move around a planet from West to East. They do not have own light, but reflect the light of the Sun. They have no atmosphere and water.

Figure 2.7 Surface of the Moon

Moon: the Earth's Satellite

The moon is located at a distance of 8, 84,401 km from the earth (Figure 2.7). The moon revolves around the earth. The moon takes 27 days and 7 hours and 43 minutes for both its rotation and revolution around the earth.

Hence, the observers on the earth could see only one side of the moon.

The moon is the fifth largest natural satellite in the solar system. The moon was likely to be formed after a Mars-sized body collided with Earth. There are many craters, high and steep mountains of different sizes which cast shadows on the Moon's surface. The light which is reflected by the Moon will reach the Earth in just one and a quarter seconds.

> **DO YOU KNOW?**
>
> Apollo 11 was the first manned mission to land on the Moon sent by NASA. Two American Astronauts Neil Armstrong and Edwin Aldrin set foot on the moon's surface on the waterless Sea of Tranquility on 20th July, 1969. They stayed there for 21 hours 38 minutes and 21 seconds on the moon. Michael Collins piloted Apollo 11.

Since the moon is smaller than the earth, it has 1/6 of the gravitational pull of the earth. So, man weighs 6 times less on the moon than the earth.

2.10 Asteroids

Asteroids are small rocky celestial bodies that revolve around the Sun, like other planets. They are also called 'Minor Planets'. There are lots of asteroids in the solar system. Larger asteroids are called Planetoids. These are found in between the planets Mars and Jupiter. This belt is known as 'Asteroid belt'. The diameter of the asteroids varies from 100 km to a size of a pebble. The asteroids may be the fragments of a planet exploded in the past or some parts of comets. The new asteroids are being discovered continuously.

2.11 Comets

Comets are the most exciting heavenly bodies and have ever been the objects of man's curiosity as well as fear. The word **Comet** (Figure 2.8) is derived from the Greek word **Aster Kometes** meaning **'Long Haired Star'**. They are made up of small ice particles and meteoric fragments. They revolve around the Sun. But their orbits are irregular. Sometimes they get very close (Perihelion) to the sun and in other times they go far away (Aphelion) from the sun.

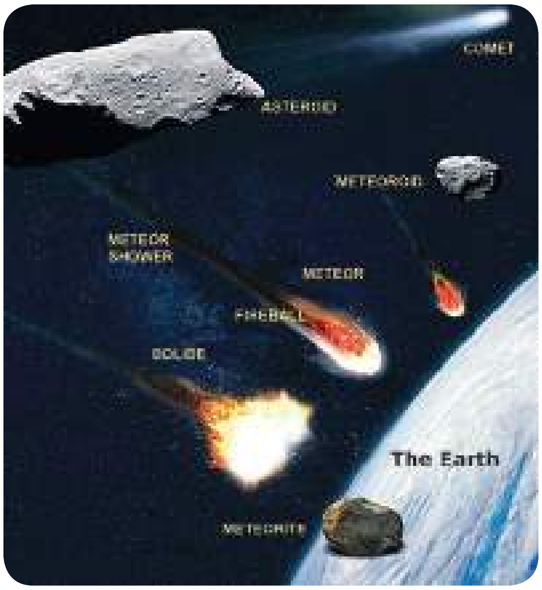

Figure 2.8 Comets

> **DO YOU KNOW?**
>
> The best known Comet, Halley's Comet, appears once in every 76 years. The Halley's Comet was seen last in 1986 and it will be seen again on 28th July 2061.

CASE STUDY

Titan – only moon with clouds and atmosphere.

Titan is Saturn's largest moon and the second largest (after Ganymede of Jupiter) in the solar system. It is the only moon in the solar system with clouds and a dense, planet-like atmosphere.

Scientists believe that conditions on Titan are similar to Earth's early years (the main difference is that, because it is closer to the sun, Earth has always been warmer). According to NASA, "In many respects, Titan, is one of the most Earth-like worlds we have found to date."

Titan was discovered by Dutch astronomer Christiaan Huygens in 1655. The Huygens lander probe sent to the moon aboard NASA's Cassini spacecraft by the European Space Agency is named in his honor. Huygens was the first human-built object to land on Titan's surface. Diameter:5,150 kilometres, about half the size of Earth and almost as large as Mars. Surface temperature: - 179 degree Celsius, which makes water as hard as rocks and allows methane to be found in its liquid form. Surface pressure: Slightly higher than Earth's pressure. Earth's pressure at sea level is 1 millibar while Titan's is 1.6 millibars. Orbital period: 15,945 days. Titan's mass is composed mainly of water in the form of ice and rocky material. Titan has no magnetic field.

2.12 Meteors

There is a bright streak of light flashing seen often in the sky during night for a few seconds. They are called as **'shooting stars'**. They are the removed pieces of rocks mainly from the Asteroid belt. They are called **Meteoroids** before they enter into our atmosphere. They enter into the atmosphere with great speed. But most of them are burnt when they enter into the atmosphere.

After entering into our atmosphere they are called as **Meteors**. Some pieces do not burn fully and they fall on the earth and make craters. The large unburned pieces of rocks that fall on the earth are called **Meteorites**.

Examples for Meteorite Fall: Meteor crater in Northern Arizona and Lake Lonar in Buldhana District of Maharastra in India were created by meteor impacts.

2.13 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 travelled south. Eratosthenes

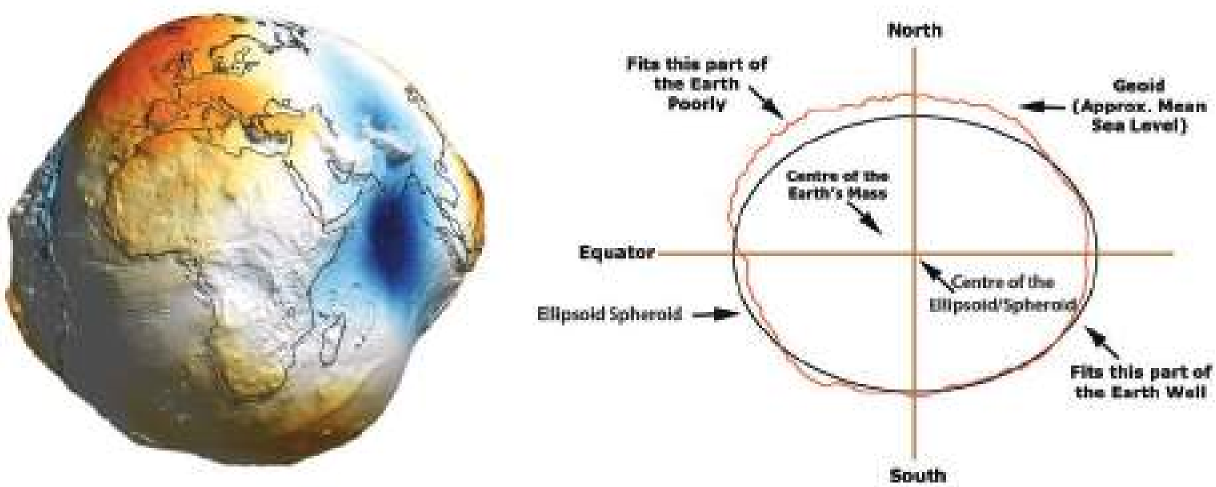

Figure 2.9 Geoid : Shape of the earth

(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.The Following Observations Show that the earth is sphere in shape

1. Mountain peaks lit by the Sun after sunset.
2. Ships disappear below the horizon as they sail across ocean.
3. The moon looks like a disc.
4. 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' (Figure 2.9) 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.

HOTS

Chimborazo in Ecuador is higher than Mount Everest, if measured from the centre of the Earth. Why?

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.

2.14 Motions of the earth

The earth has two basic movements: 1) Rotation and 2) Revolution.

DO YOU KNOW?

Galactic movement: This is the movement of the earth with the sun and the rest of the solar system in an orbit around the centre of the MilkyWay Galaxy. This, however, has little effect upon the changing environment of the earth.

1. **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

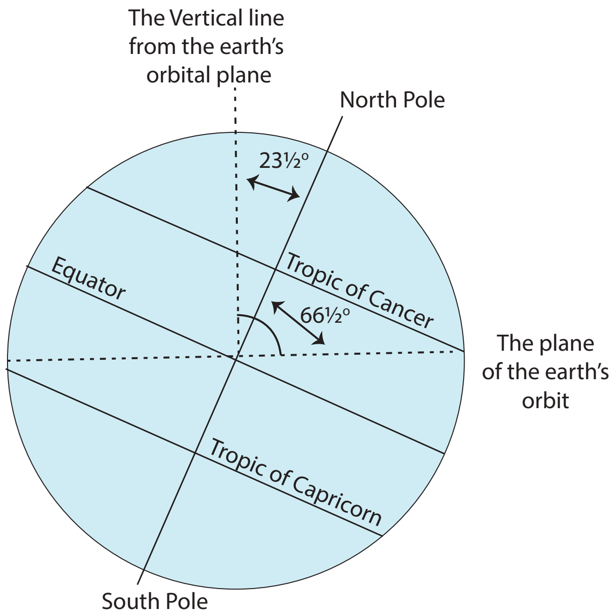

Figure 2.10 Tilt of the Earth's axis

to the apparent movement of the sun. The earth's axis is inclined at an angle of 66½° to the orbital plane as it moves around the sun. We can say, the earth's axis is tilted at an angle of 23½° (Figure 2.10) 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 and in the poles it is about zero.

Effects of earth's rotation: The rotation of the earth causes the following effects:

1. 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.
2. 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.
3. 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.
4. Rotation causes the working of the Coriolis force which results in the deflection of the winds and the ocean currents from their normal path.
5. 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 (Figure 2.11).

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

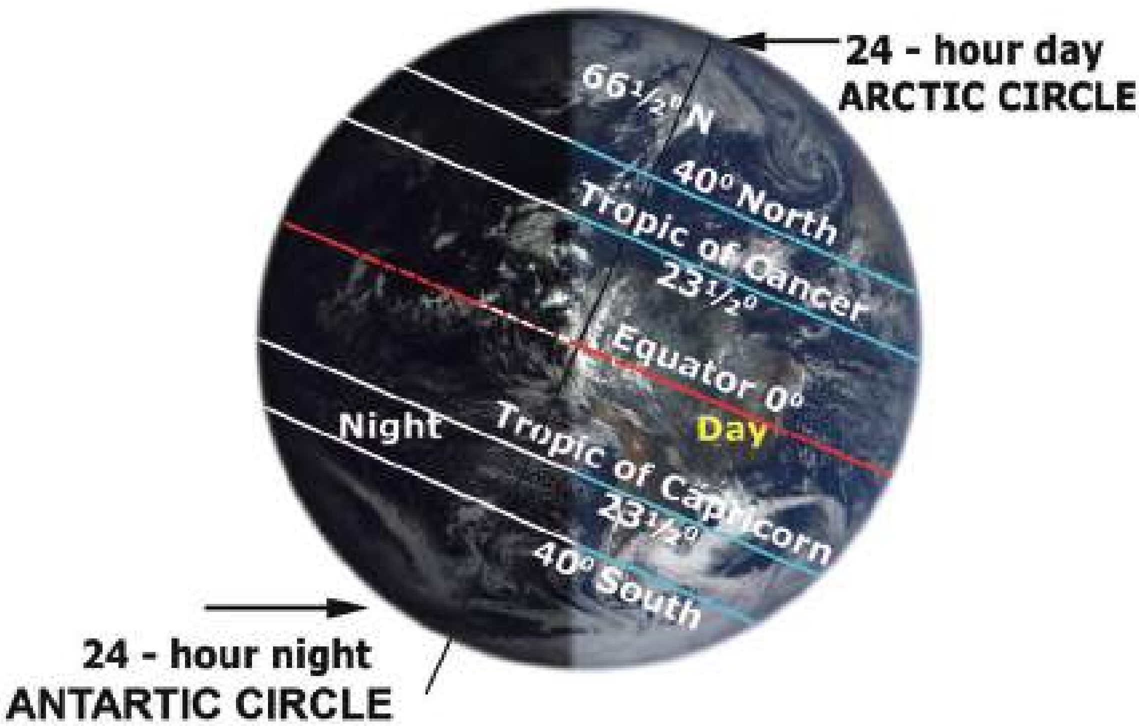

Figure 2.11 Circle of Illumination

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

Difference between Rotation and Revolution

Rotation	Revolution
Spinning of the earth from west to east on its axis.	Movement of the earth around the sun in its elliptical orbit.
It takes 24 hours to complete a rotation (or a day)	It takes 365¼ days to complete one revolution (or a year)
It is known as the daily or diurnal movement.	It is known as the annual movement of the earth.
Rotation causes days and nights to alternate, tides, deflection of winds and ocean currents and also gives the earth its shape.	Revolution results in the varying lengths of day and night, changes in the altitude of the midday sun and change of seasons.

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.

> **Brain storming**
>
> How many birth days a person, whose life span supposed to be 60 years, would have seen in his/ her life time, if born on 29th February?

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.

2.15 Seasons

The seasons are caused due to the combined effect of the earth's revolution and the tilt of its axis to 23½° in the same direction throughout the year. In general, spring, summer, autumn and winter are the four seasons (Figure 2.12). 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.

> **Let us know!**
>
> How to calculate leap year? Take any year and divide by 4. If it is divisible (whole number with no reminder), it is a leap year.
>
> Students' activity: calculate and identify the leap years from the following years
>
> 1992, 1995, 2000, 2005, 2008, 2010, 2012, 2014, 2017, 2020, 2024, 2030, 2035, 2040 and 2044.

Equinoxes and solstices

You already knew that the sunrays are vertical at noon. The vertical rays fall on a small area, giving more heat.

Equinoxes

Position of the earth on 21 March

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

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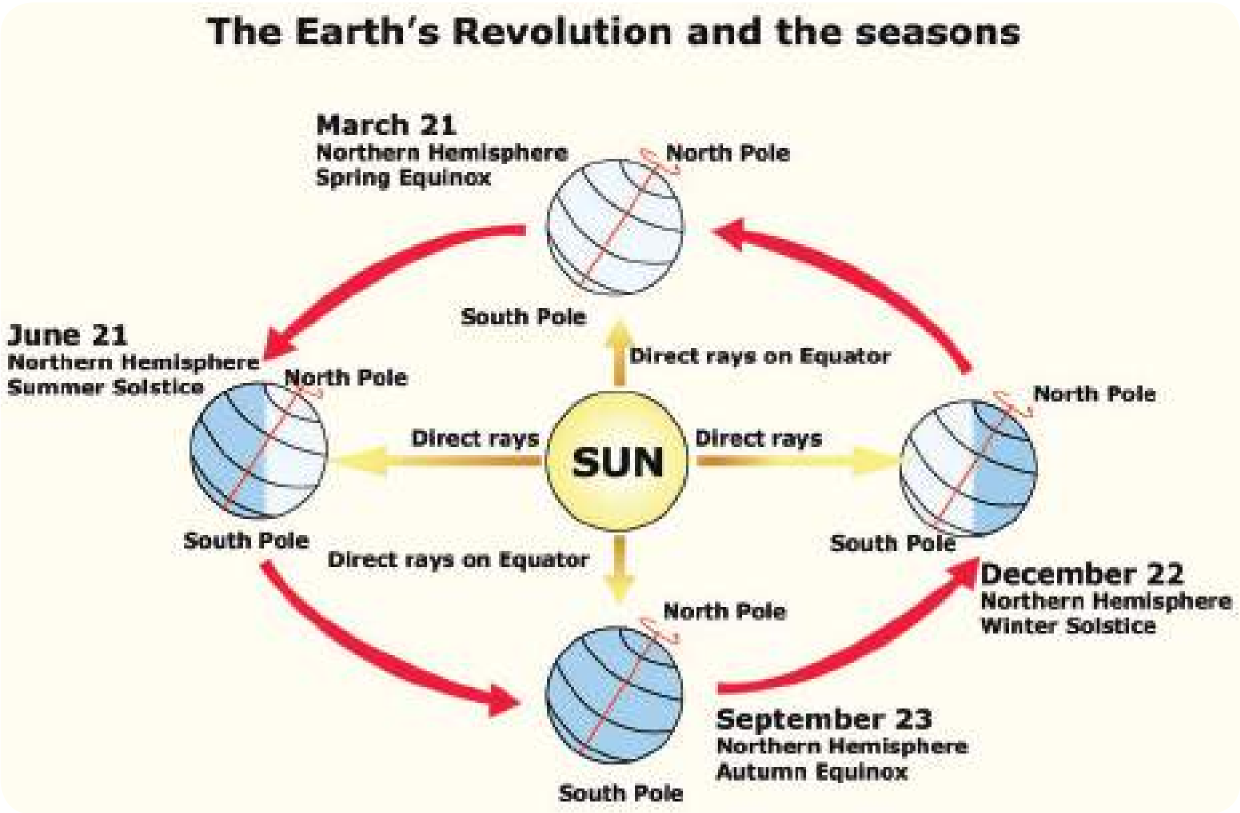

Figure 2.12 Earth's revolution and the seasons

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.

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. Again on 23 September the sun is directly overhead on the equator and it is called autumn equinox. This day (23 September) when sun's rays for fall verticaly on the equator, is known as autumnal equinox (Figure 2.13).

SolsticesPosition 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 (Table 2.2). 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

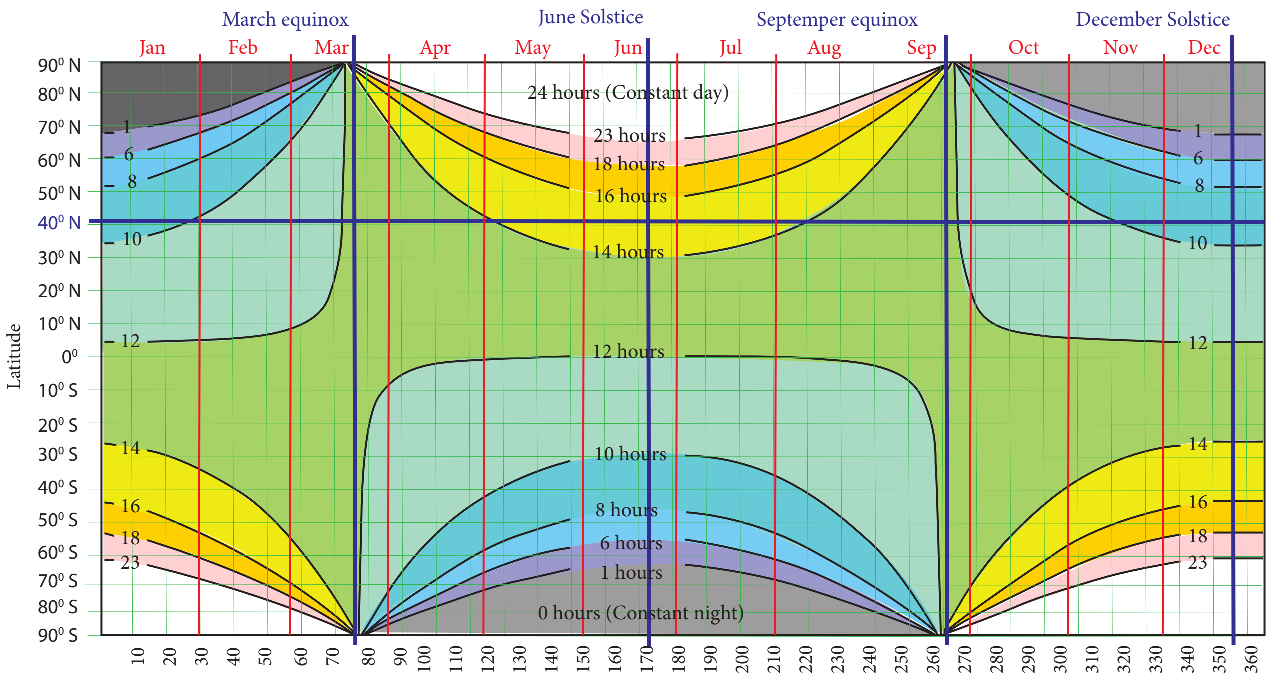

Figure 2.13 Variations in the Length of Day and Night

Table 2.2 Variation in the length of day time

Latitude	Summer Solstice	Winter Solstice	Equinoxes
0°	12 hrs	12 hrs	12hrs
10°	12hrs 35 min	11hrs 25 min	12hrs
20°	13hrs 12min	10hrs 48min	12hrs
30°	13hrs 56min	10hrs 4 min	12hrs
40°	14hrs 52 min	9 hrs 8 min	12hrs
50°	16hrs 18min	7 hrs 42 min	12hrs
60°	18hrs 27min	5 hrs 33min	12hrs
70°	24 hrs (for 2 months)	0 hrs 00 min	12hrs
80°	24 hrs (for 4 months)	0 hrs 00 min	12hrs
90°	24 hrs (for 6 months)	0 hrs 00 min	12hrs

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. They are:

A) 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** (Figure 2.14) 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**.

(b) 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 (Figure 2.15). **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

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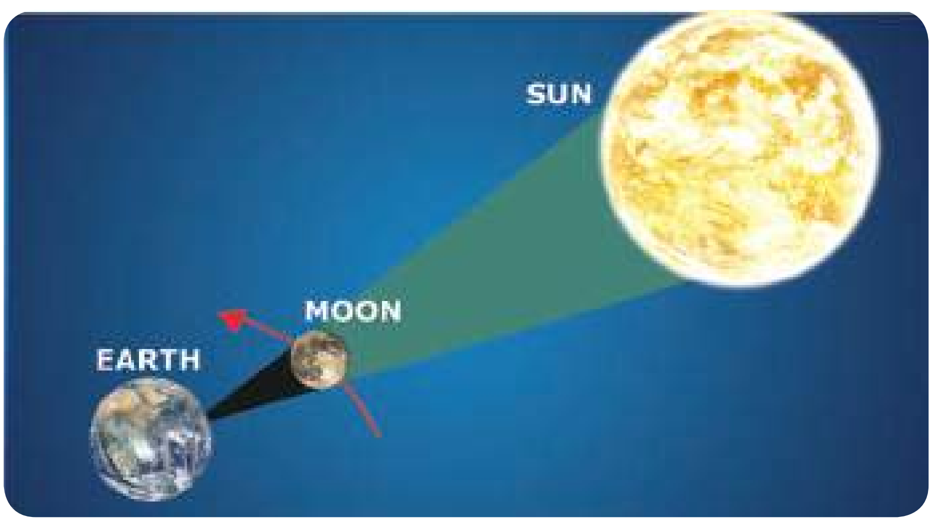


Figure 2.14 Solar eclipse

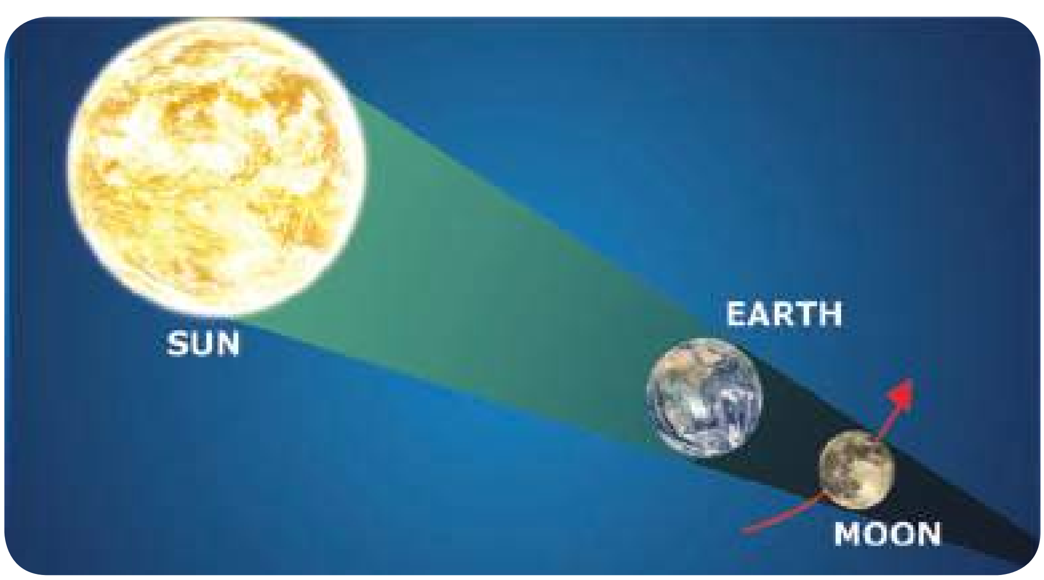


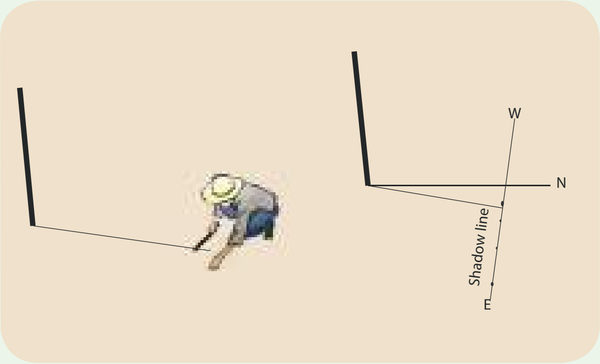
Figure 2.15 Lunar eclipse

Fact File

Geo connects History

Secret to **Great Pyramid's** Near Perfect Alignment Possibly Found!

The Great Pyramid of Giza, 4,500 years ago, is an ancient feat of engineering. Now an archaeologist has figured out how the Egyptians may have aligned the pyramid almost perfectly along the cardinal points, north-south-east-west. Egyptians may have used **the autumn equinox**. Methods used by the ancient Egyptians to align the pyramids along the cardinal points are accurate.



On the day of the fall equinox, a surveyor placed a rod into the ground and tracked its shadow throughout the day. The result was a line running almost perfectly east-west. The Egyptians could have determined the day of the fall equinox by counting forward 91 days after the summer solstice.

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 (Figure 2.16) 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.

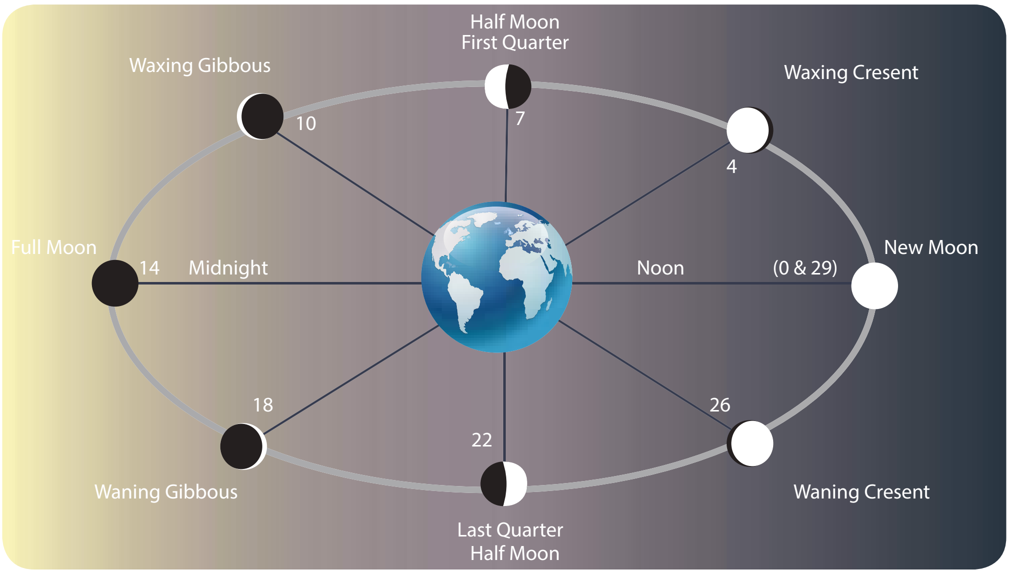


Figure 2.16 Phases of the Moon

Effects of the spherical shape of the earth

1) 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.

2) 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.

Heat 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.

2.16 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 (Figure 2.17) 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. You have already learned about the latitudes and longitudes and their importance in the lower classes.

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 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

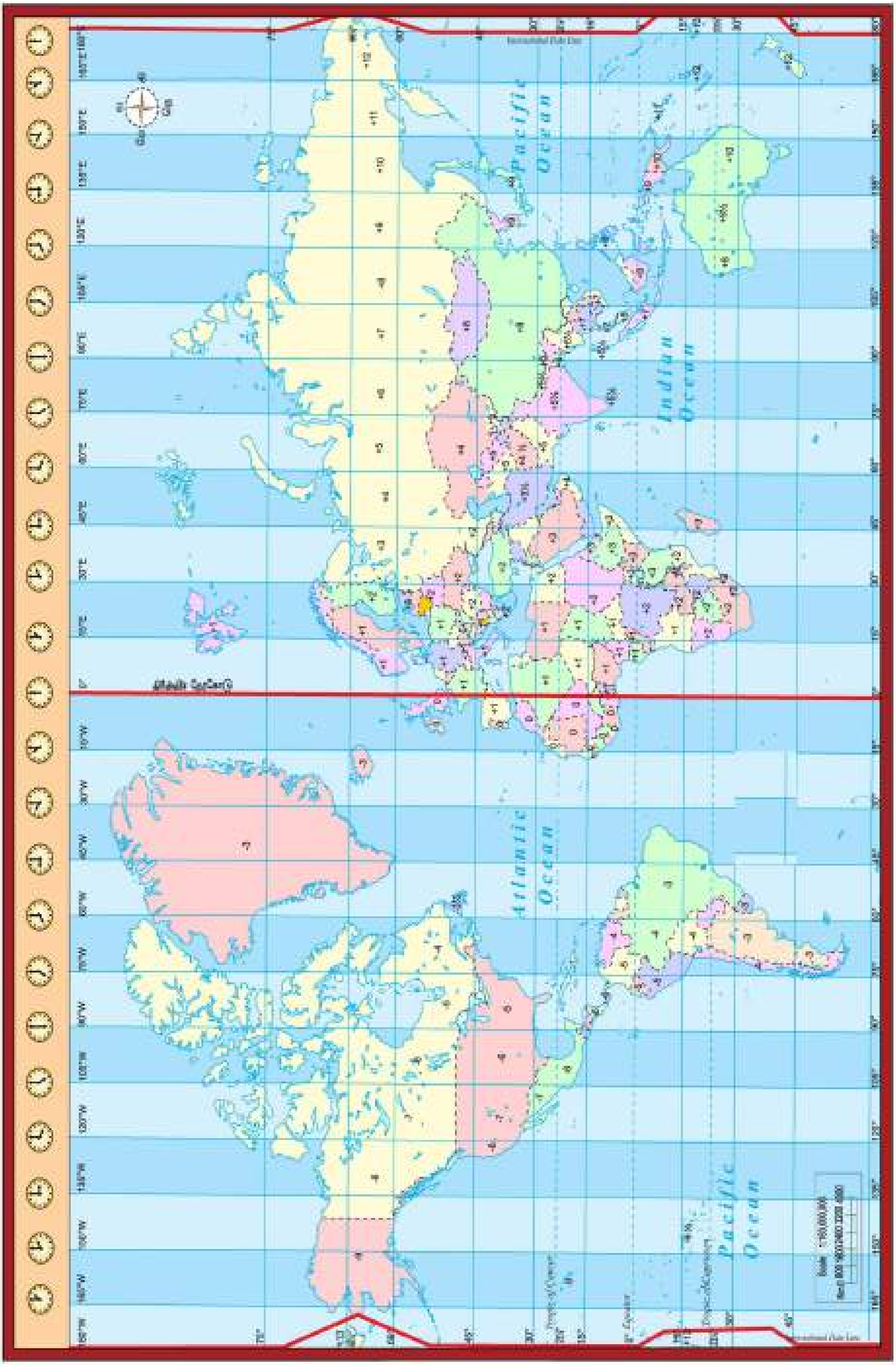


Figure 2.17 Time zones of the world

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 (Figure 2.18). This too helps to determining different time zones of the world.

Together all of the above information can be used to calculate the difference of time between two locations.

1. First, we need to know what longitudes the two places are located.
2. Next, you would need to find the differences in longitude (in degrees) between the two places. If both places are located on the same side of the Prime Meridian, then the numbers are just simply subtracted to find the difference. If they are on the opposite side of the Prime Meridian then the two numbers should be added together to find the difference.

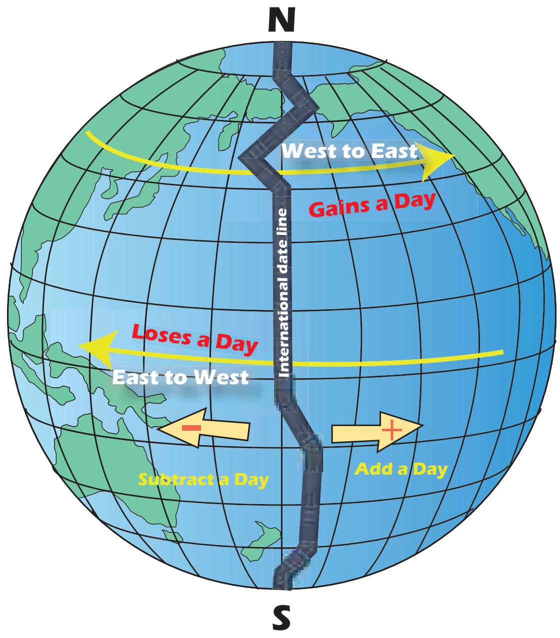


Figure 2.18 International date line

3. Third, we need to divide the difference (measured in degrees) by 15 since there are 15 degrees in every hour. This will give us the difference in time between the two locations. So if you know what time it is in one location, and the longitude of another location, then just simple addition or subtraction problem will give us the time in a different time zone. Let's look at another way we may have to calculate the difference between times of two locations.

Another calculation you may have to make is over the International Date Line. This line is strategically placed in the Pacific Ocean so that no two neighbouring cities are one day apart in time. It can be difficult to calculate though the International Date Line when trying to determine the amount of time difference between locations on either side. This calculation is very similar to the situation with the Prime Meridian. We must start by finding the difference in longitude (or degrees) of the two places. We do this by adding the two numbers. Then, divide by the 15 degrees that occurs in one hour and this will give you the time difference between two locations through the International Date Line. And again, just add or subtract that difference from the time that we already know to come up with the new time in the new time zone.

Example of Time Calculations

To review, to find the difference between the two longitudes and divide by 15, this gives you the difference in hours between the two locations. Second, add or subtract the number of hours from the time of day that was already known, we will need to add the numbers if we are going east, and subtract if we are going west. Here are some examples of how we may need to calculate the difference of time zones.

If you are in London at 12:00, and want to know what time it is in Japan, you would need to first figure out that London is 0 degrees (right on the prime meridian), and Japan is 135 degrees East. So the difference is 135 degrees (135–0), divided by 15 which equals 9. It means there is a 9-hour difference between London and Japan. Since Japan is further east than London is, you would add 9 hours to 12:00. The answer is at 12:00 noon London time, it is 9:00pm in Japan.

Now we suppose imagine that we are going through the International Date Line. Pretend you are in Japan, which is 135 degrees east and you wanted to know what time it is in Hawaii, which is 150 West. Well, there is 45 (180–135) degrees difference between Japan and the IDL. Also there is 30 (180–150) degrees difference between the IDL and Hawaii. Therefore the difference in time is (45 + 30/15 = 5) 5 hours. Now the tricky part is that Japan and Hawaii are on different days. It is one day ahead on the left side of the IDL compared to the right side. If it is 3:00pm in Japan on Thursday that means it is 3:00 + 5 hours = 8:00pm in Hawaii. However notice that when crossing the IDL we subtract a day going east. So, in Hawaii it is 8:00pm on Wednesday.

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

360° = 24 hours = 1440 min (24 × 60)

Difference of time for 15° longitude = one hour.

Difference of time for 1° longitude = 4 minutes.

Longitude Calculations Procedures

a. First locate the two places involved
b. Find the longitude difference
c. Convert the longitude difference to time and,
d. Adjust the time according to the direction of movement, (west or east).

Example 1

Ponni starts her journey at longitude 0° at 12 noon and she's moving towards eastward of longitude 10°. Calculate the time that Ponni will arrive at her destination.

Solution

Initial time = 12 noon

Destination = 10°E

Conversion of degree to time

1 hour = 15°

and 4 minutes = 1°

Hence 10° = (4 × 10) minutes

= 40 minutes

Destination time = Initial time + calculated time

= 12 noon + 40minutes

= 12:40pm

Example 2

If the time at village A (long 75°W) is 5:00 pm on Friday. Calculate the time and day at village B (long 120°E)

Solution

360° = 24hrs

15° = 1 hour

1° = 4 minutes

Village A = 75°W

Village B = 120°E

We will add (west and east)

(75 + 120)° = 195°

195 divided by 15°

= 13hrs

Destination time = initial + calculated time

= 5:00 + 13 hrs

= 18:00

18:00 = 6:00

Answer = 6:00am on Saturday

Example 3

Calculate the local time in New York (USA) longitude 75°W, when it is 10am in Nigeria of longitude 15°E

Solution

Initial time = 10:00am

New York = 75°W

Nigeria = 15° E

We will add (west and east)

(75 + 15)° = 90°

90° divided by 15° = 6 hrs

Destination time = initial + calculated time

= 10:00am + 6hrs

= 16:00 hrs

16:00 hrs = 4:00pm

Answer = 4:00pm

A-Z GLOSSARY

1. **Dark energy:** A theoretical form of energy postulated to act in opposition to gravity and to occupy the entire universe, accounting for most of the energy in it and causing its expansion to accelerate.
2. **Magnetic field:** A force field that is created by moving electric charges and magnetic dipoles, and exerts a force on other nearby moving charges and magnetic dipoles.
3. **Penumbra:** The partially shaded outer region of the shadow cast by an opaque object.
4. **Asteroids:** Small rocky celestial bodies that revolve around the Sun, like other planets.
5. **Standard time:** A uniform time for places in approximately the same longitude, established in a country or region by law or custom.
6. **Galactic movement:** This is the movement of the earth with the sun and the rest of the solar system in an orbit around the centre of the MilkyWay Galaxy.
7. **Equinox:** Time, when the apparent movement of the sun is overhead the equator, equal day and night occurs.
8. **Gibbous:** Third quarter of moon's phase is known as Gibbous.
9. **Solar flare:** A magnetic storm on the sun and releases huge amounts of gases. It can cause 'Sun quakes'.
10. **Super Nova:** The explosive death of a star. It obtains brightness of 100 million suns for a short time.

Evaluation

I. Choose the best answer from the options given

1. The scientist who proposed Big Bang Theory was
   a. Abbe Georges Lemaitre
   b. Edwin Hubble
   c. Nicholas Copernicus
   d. Aryabhatta
2. ____________ is called the Morning and Evening Star in the Solar system.
   a. The Mercury b. The Venus
   c. The Uranus d. The Saturn
3. The Planet with 30 rings in the solar system is ____________
   a. The Jupiter b. The Mars
   c. The Earth d. The Saturn
4. The earth takes ____________ to complete one rotation.
   a. 23 hrs 56 min 4 sec
   b. 27 hrs 17 min 2 sec
   c. 24 hrs 56 min 4 sec
   d. 10 hrs 7 min 4 sec
5. The windiest planet is
   a. The Saturn b. The Neptune
   c. The Jupiter d. The Mars
6. The sun appears to be the closest to the earth on
   a. January 3 b. July 4
   c. September 5 d. December 4
7. The length of day time at 80^0 N during summer solstice is
   a. 18hrs 27min
   b. 24 hrs (for 2 months)
   c. 24 hrs (for 4 months)
   d. 24 hrs (for 6 months)
8. The apparent movement of the Sun is overhead the Equator twice a year on
   a. Dec 22 and Mar21
   b. Mar21 and Sep23
   c. Jun 21 and Dec 22
   d. Sep 23 and Dec22
9. On June 21 the Sun's rays fall vertically on the
   a. The Tropic of Cancer
   b. The Tropic of Capricorn
   c. The Equator
   d. The Arctic Circle
10. The Prime Meridian is the centre of time zone extending between
    a. 7 ½° W and 7 ½° E longitudes
    b. 7 ½° N and 7 ½° S
    c. 17 ½° W and 17 ½° E Longitudes
    d. 17 ½° N and 17 ½° S

II. Very short answer

11. Define a star.
12. Why is the Venus hottest?
13. Mention any two differences between the Mercury and Neptune.
14. What are the inner planets?
15. Define the circle of illumination.

III. Short answer

16. What are dwarf planets?
17. Why could we see only one side of the Moon always?
18. Mention the characteristics of the Saturn.
19. Distinguish between the solar eclipse and lunar eclipse.
20. Calculate the local time of Chennai (80^0 27' E) when it is 8 pm in Shangai (121^0 47' E).

IV. Detailed answer

21. Explain the Big bang Theory.
22. Describe the structure of the Sun.
23. Draw the four positions of the Sun during equinoxes and Solstices and briefly explain them.

V. Additional questions

1. Lines of latitude
   a. begin with the prime meridian
   b. are designated by being East or West from an origin;
   c. are of equal length;
   d. become shorter away from the equator;
   e. none of the above.
2. All of the following are true statements about longitude, except
   a. has its origin at the prime meridian;
   b. extend east and west to 180 degrees longitude;
   c. are relatively equal in length
   d. could be determined by sailors using a device called the sextant
   e. could not be determined by sailors until the introduction of the chronometer.
3. You are told that the earth rotates on its axis at a speed of about 1042 miles per hour. Given that the rotation occurs in 24 hours, what is the circumference of the earth?
   a. 40,000 miles
   b. 25,000 miles
   c. 2400 miles
   d. 76,000 miles
   e. none of the above.
4. How many degrees of a full circle can you travel eastward or westward from the zero (prime) Meridian before heading back toward the Prime Meridian?
   a. 60 degree.
   b. 90 degree.
   c. 360 degree.
   d. 180 degree.
   e. none of the above.
5. 0 degree longitude and 0 degree. latitude is located:
   a. over central Australia;
   b. in Brazil
   c. in the Atlantic south and west of Africa
   d. at the South Pole
   e. none of the above.
6. To find longitude, a sailor needs to know
   a. the elevation of the sun above the horizon
   b. the latitude at the prime meridian;
   c. local time and the time at another line of longitude
   d. the relative space
   e. none of the above.
7. Latitude and longitude is a spherical coordinate system with its origin at 0 degree latitude and 0 degree longitude. This point is in the Atlantic Ocean just below the African country of the Ivory Coast. Locations are measured in degrees away from this origin in north, south, east and west directions. 23.34 degree S and 46.38 degree W is probably located in:
   a. Russia
   b. Canada
   c. South Africa

d. South America
e. None of the above.

8. The circumference of the earth at the equator or along any line of longitude is approximately:
   a. 25,000 km
   b. 40,000 km
   c. 36,000 km
   d. 46,000 km.
9. It is 1:00 PM on Friday at 90 degree W. what time is it at 90 degree E?
   a. 7:00 PM Friday
   b. 7:00 AM Friday
   c. 7:00 AM Saturday
   d. 1:00 AM Saturday
   e. 1:00 PM Saturday
10. It is 12 Noon, Monday at 90 degree. W. what time and day should it be at 75 degrees east longitude?
   a. 11PM, Monday
   b. 11 AM, Tuesday
   c. 1 AM, Monday
   d. 11 PM, Tuesday
   e. 6 AM, Monday

VI. Practice

1. Prepare a working model of the Solar system as a group work and demonstrate in the class.
2. Collect and prepare in a chart, the facts about the sun, planets, satellites, asteroids, comets and meteors and make a news reading of each heavenly body in the school assembly each one day.
3. Collect latest information on the "Planet 9" and present it in the classroom.

Reference

1. Geography by Surender Singh.
2. Geography by Vee Kumar publications.
3. Solar system. Nasa.gov.com

ICT CORNER

Time zone and Eclipses Conflicting Clocks

Through this activity you will identify time zones and Eclipses.

Steps

- Use the URL to reach the 'Time Zone Map' page or scan the QR code.
- Use the mouse and surf over the interactive map to observe the time variations and current time in a particular place.
- Select 'Eclipses' under 'Sun and Moon' menu to observe eclipses and transits of planets.
- Click 'See list of all eclipses & planet transits worldwide (1900 to 2199)' option form the list and use the interactive map to identify date and paths of eclipse and transits.

Step 1

Step 2

Step 3

Step 4

Website URL:

https://www.timeanddate.com/time/map/

*Pictures are indicative only.

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