CHAPTER - 15

STARS AND THE SOLAR SYSTEM

15.1 Introduction

The earth is the third planet which revolves around the sun. There are eight more planets which revolve around the sun. You will learn more about the sun, the planets and other heavenly bodies in this chapter.

15.2 What are Heavenly Bodies or Celestial Bodies ?

We, the human beings, live on the surface of the earth. What we look up, what do we see ? Obviously, we see the sky. The sky appears blue on a clear day, but is dark at night. Why is it so ? This is because during the day, it is the sunlight which makes it appear blue. But what is really the sky ? Well, the vast empty space can be called sky.

During the day-time, we see a bright ball of fire in the sky which appears to move from the east to the west. We call it the sun. At night, we see thousands of stars in the sky. If we watch the sky through a telescope we may see millions of stars, some of which are brightly coloured. We see certain groups of stars which appear to be in clusters. They are called **constellants.** There is the moon whose size changes every day. The moon is a natural satellite of the earth. It completes one revolution around the earth in 27⅓ days. Furthermore, we see an occasional comet. It appears as a ball of fire, having a tail. Then, there are shooting starts or meteors. They appear to fall from the sky. In addition to it, there are planets like the morning stars.

Bodies such as the earth, moon, planets, sun, stars, meteors, comets, etc., are called **heavenly bodies** or **celestial bodies.**

15.3 What is Universe ?

The vast unimaginable space which encompasses most distant stars, planets and anything else, which exists is called universe.

15.4 What is Astronomy ?

The branch of science which deals with the study of universe is called astronomy. The study of astronomy involves the methods and instruments used for the study of the universe. We know a lot about the universe from the information already gathered by the astronomers.

15.5 The Night Sky

After sunset, the night sky is dotted with bright stars. On a clear night (when there is no dust or clouds in the sky) one can see about 3000 stars with the unaided eye. However, if the sky is viewed through a good telescope, many more stars are visible. Most of the stars are yellow in colour, but some stars are white or red in colour. Another property of the stars is that they appear to twinkle. The twinkling stars takes place due to the atmosphere of the earth. However, if the stars are viewed from above the atmosphere, as in the case of a spaceship, they do not twinkle, but appear to shine more brightly.

Another prominent object visible at night is moon, whose size changes every night. In addition to it, there are star-like objects, which do not appear to twinkle. These are planets. They revolve around the sun in the same way as our earth. Then there are shooting stars (meteors), they appear to fall from the sky with a long, bright streak of light.

15.5.1 Why are Stars not Visible during Day Time ?

During day-time, the light from the sun is so strong that it suppresses the light coming from the stars, and hence, they are not visible to us.

15.5.2 How do the Stars Emit Light ?

All stars are giant balls of hydrogen gas and this includes our sun which is a medium star. At the core (centre) of this giant hydrogen cloud, the temperature is from 2 million to 5 million degree celsius. At such a high temperature, the hydrogen gas fuses (joins or melts) to form a heavier gas called helium, with the liberation of a huge amount of heat and light energy. Thus, it is the fusion of hydrogen gas within the core of the star which emits light energy.

15.5.3 The Sun

The sun is the nearest star from the earth. Our sun is a medium order star in terms of its mass and brightness. You may wonder as to why the sun does not appear like the other stars or why does it appear bigger and hotter than other stars in the sky?

This is because the sun is very close to the earth as compared to other stars. For example, the distance of the sun from the earth is 150 million kilometers. Whereas the distance of the nearest star (after sun) from the earth (Alpha Centauri) is 40678000 million kilometers. It is on account of these enormous distance that stars appear very small and appear to have much less heat and light as compared to the sun.

15.5.3.1 How big is the sun as compared to earth ?

The diameter of the sun is 1,400,000 km (approx). This diameter is 109 times the diameter of the earth. Thus sun is approximately 300,000 times heavier than the earth.

15.5.4 What are Units of Measuring the Distance of Stars from the Earth ?

Most of the stars are so far away from the earth, that even the light which travel at a speed of 3×10^5 km/s (300,000 km/s) takes million of years to reach on the earth. Thus, the distances of the stars are measured in light years.

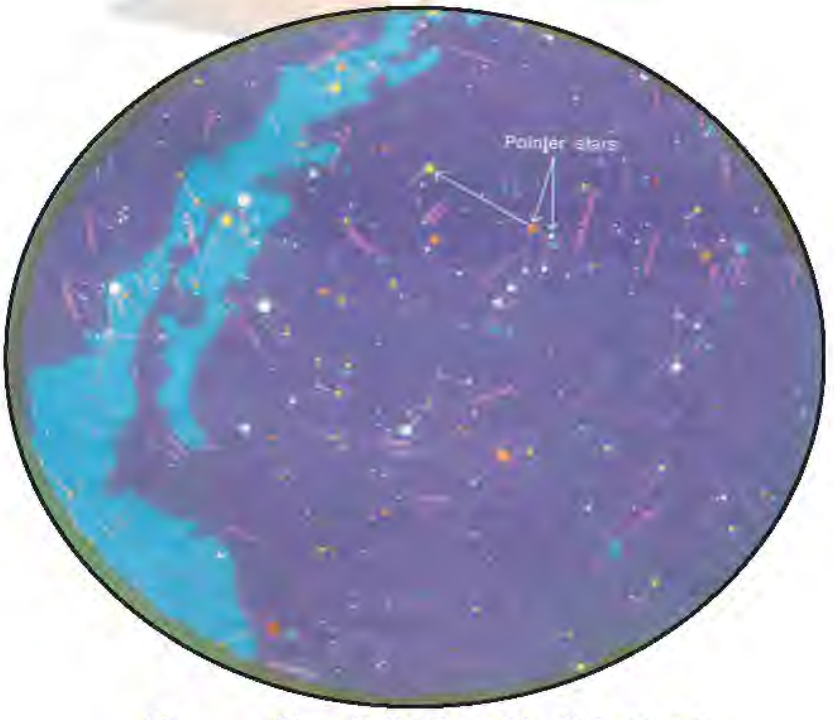

Fig. 15.1 : Stars in Northern Sky in Summer

What is a Light Year ?

The distance travelled by the light at a speed of 300,000 km/s in one year (365 days) is called light year.

1 light year = speed of light x 365 days

= 300,000 km/s x 365 x 24 x 60 x 60s

= 9,460,000,000,000 km

= 9.46×10^{12}km

What is a Light Minute ?

The distance travelled by the light at a speed of 300,000 km/s in one minute (60 seconds) is called a light minute.

1 light minute = 300,000 km/s x 1 minute

= 300,000 km/s x 60s

= 18,000,000 km = 18×10^{6} km

15.5.4.2 How far Is the nearest star Alpha Centauri, from the earth in kilometers ?

Alpha Centauri is at a distance of 4.3 light years.

Therefore, Distance in kilometer = Distance travelled in one light year x Number of light years

= 9.46×10^{12} km/light year x 4.3 light years

= 40.678×10^{12}km.

15.5.4.3 Why do the stars appear to us like point objects ?

The stars, much like our sun are celestial bodies, which continuously emit heat and light. Our sun is a medium sized star. It appears bigger to us, because it is nearest to the earth. The stars appear to us like points, because they are very far away from the earth. Most of the stars are so much far away, that the light from them takes million of years to reach the earth.

15.5.4.4 Appeared to be changed the distance between any two stars not change when viewed from the earth ?

Stars are moving away from each other at a very high speed. However, when viewed from the earth, the distance between them does not seem to change, because they are very far away from us. Hence, any change in the distance between them does not become perceptible in few hundreds of years.

15.5.4.5 Why do the stars appear to move from east to west ?

It is because the earth rotates about its north-south axis from west to east . Thus due to relative motion, all heavenly bodies (stars, planets, moon), etc., appear to move from east to west.

15.5.4.6 Why does the pole star (Polaris or Dhruva Tara) not change its position in the sky ?

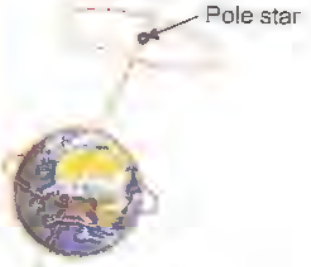

Fig. 15.2 The Pole Star lies on the Axis of Rotation of the Earth

The pole star is situated in the direction, which is directly above the geographic north-pole of the earth's axis. Thus, its position relative to the earth does change and hence, it appears stationary.

15.6 Constellations

A group of stars which forms a recognisable pattern or shape is called a constellation.

Astronomers have divided the whole sky into 88 constellations. Each constellation is assigned a name of the object to which it closely resembles. In ancient Indian astronomy, the constellations

were known as **Nakashatras.** A few of the prominent constellations are discussed below.

(I) Ursa Major or Big Dipper or Vrihat Saptarishi

This constellation consists of 7 bright stars arranged in a pattern somewhat resembling the shape of a big bear. The stars marked 1, 2, 3 and 4 represent the body and the stars marked 5, 6, and 7 represent the tail of the big bear. The head and paws of the big bear are formed by some faint stars, not shown in diagram.

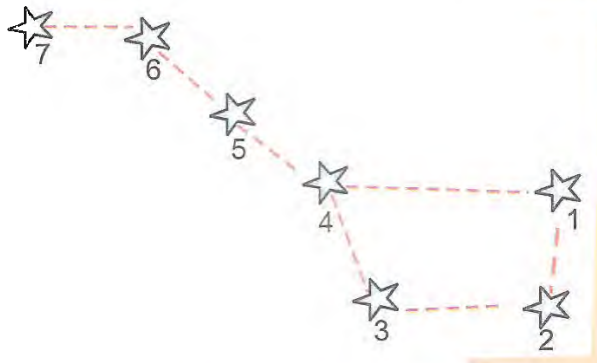

Fig. 16.3 Ursa Major

The Ursa Major constellation can be linked to the following objects :

(i) It looks like an oversized ladle in which stars marked 1, 2, 3, and 4 form the cup of the ladle and stars marked 5,6 and 7 form the handle.

The stars 1 and 2 at the end of the cup of the ladle are called pointer stars, as they point in the direction of the pole star.

(ii) It looks like a question mark suspended across the sky, where the stars 1, 2, 3 and 4 form the curved path and the stars 5,6, and 7 straight line part of the question mark.

(iii) It resembles a kite having a long tail.

The Ursa Major is visible clearly in the northern part of the sky in the summer months, between April to September.

(2) Ursa Minor or Laghu Saptarishi or Dhruva Matsaya

Ursa Minor constellation is also a group of seven stars, similar to that of Ursa Major. However, the stars in Ursa Minor are closer and dimmer as compared to the stars of Ursa Major. They form an outline of a ladle or a kite. At the tail of Ursa Minor is a star of average brightness. It is called **pole star** or **polaris**. In Indian astronomy, the pole star is called Dhruva Tara. Ursa Minor is clearly seen in northern sky in July in summer.

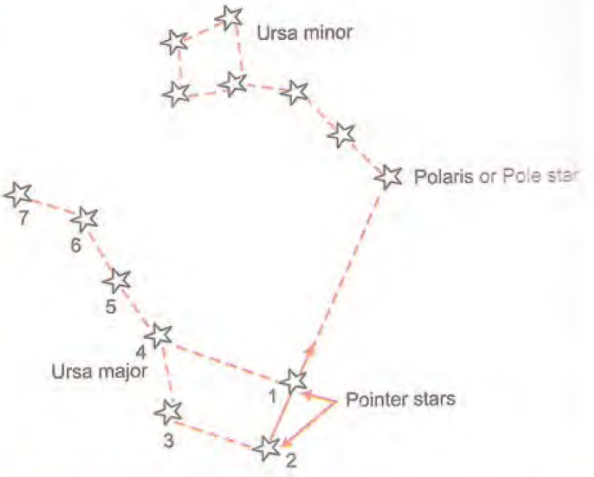

Fig. 15.4 Relative Positions of Ursa Major and Ursa Minor.

How to locate the pole star ?

Look straight in the direction of the stars situated at the far end of the ladle in Ursa Major (stars 1 and 2). The star of medium brightness in the direction of the above stars is the pole star **(Fig. 15.4)**. The stars 1 and 2 in Ursa Major which point in the direction of the pole star are called pointer stars.

(3) Orion or Hunter or Mriga or Vyadha

Orion is another constellation of 7 stars and is one of the most magnificent constellations in the winter sky. Its name in Indian astronomy is Vyadha or Mriga. It looks like a hunter with his shield and club upraised **(Fig. 15.5)**. The seven major stars in it form the body of the hunter. The head and limbs are formed by faint stars, not shown in **Fig. 15.5**.

In the orion, four stars form a kind of rectangle. In the one corner of this rectangle is situated the largest star called Betelgeuse, whereas another bright star called Rigel, is situated on the opposite corner. There are three prominent stars which are situated in the middle of the constellation forming a straight line.

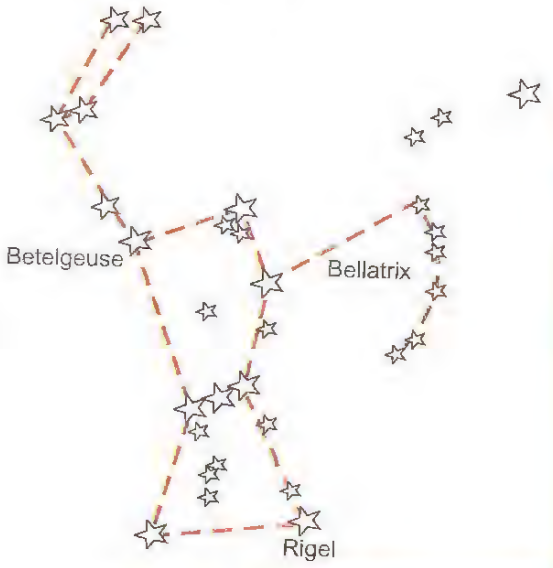

Fig. 15.5 Orion or Mriga

15.7 The Moon

The moon is the only natural satellite of the earth and is our nearest neighbour in space. It is the brightest object in the sky, next to the Sun.

The surface of the moon is rugged. It is made of very large craters (deep depressions or holes) and very high mountains. It has no atmosphere, and hence, no life on it. Its gravitational pull is one sixth that the earth.

The moon always presents its same face towards the earth. On the day side of the moon, the temperature could be as high as 110°C. On the contrary, the temperature on the night side of the moon could be as low as - 150°C.

15.7.1 Phases of the Moon

The moon is a non-luminous body. It has no light of its own. It only reflects the light of the sun falling on its surface. When this reflected light reaches the earth, we see the moon. Only that part of the moon is visible, which reflects the sunlight towards the earth.

On the New Moon day, the moon is between the sun and the earth. Thus, the reflected light from the moon does not reach the earth and hence it is not visible,

In a way, the dark side of the moon is facing us on New Moon day.

The night, just after the new moon day, we see the crescent Moon. It is because only the reflected light from the crescent part reaches the earth. The rest of the moon is only faintly visible, because the sunlight reflected from the earth also falls on the moon's disc.

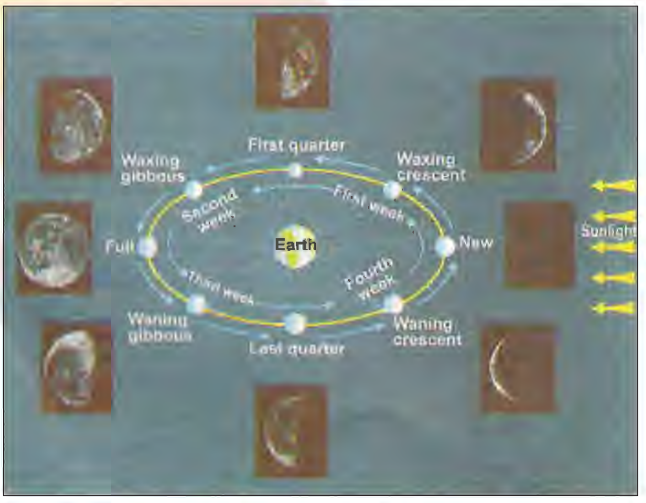

Fig. 15.6 Phases of the Moon

The crescent goes on increasing every day, till on the fifteenth day (from the New Moon day), the full bright face of the moon is visible. On this day the earth is between the sun and the moon, such that the night side of the earth is facing the day side of the moon. This is called Full Moon day. This gradual increase in the bright disc of the moon is called waxing of the moon.

After the Full Moon, the bright face of the moon goes on decreasing every night. This decrease in the bright disc of the moon is called waning of the moon. By another fifteen days, New Moon is formed.

This waxing and waning of the disc of the moon, as the moon revolves around the earth is called phases of the moon.

The moon revolves around the earth. As the earth moves around the sun, in the same way the moon revolves around the sun, along with the earth. The moon completes one revolution around the earth in $27\frac{1}{3}$ days. It takes exactly the same time to spin once about the axis. Due to the same time for rotation on its axis and revolution around the earth, it always presents the same face towards the earth.

However, as the moon revolves around the earth, the earth moves ahead in its own orbit around the sun. Thus, from the earth the moon appears to complete one revolution between one New Moon to next Moon in 291 ½ days. Lunar calendars commonly used by astrologers are based on the fact that the Moon completes one revolution around the Earth in 29½ days.

Test Yourself

1. What are celestial bodies ? Name any three celestial bodies.
2. Why do you classify the sun as a star ?
3. Why do the stars appear like point objects ?
4. What is a constellation ? How does the constellation differ from a star ?
5. Name a star which appears stationary from the earth. In which constellation is it situated ?
6. What is "a light minute?" How many light minutes is the earth from the sun? Express this distance in kilometers?
7. How much time is involved from one new moon to another new moon as seen from the surface of the earth ?
8. In how much time does the moon complete one rotation about its own axis ?

15.7 Planets

A solid heavenly body which revolves around the sun in a well defined orbit is called planet.

If you carefully look at the clear night sky, you will find some objects which (i) appear bigger and brighter than the stars (ii) they do not twinkle (iii) they change their position with respect to the other stars. These bright objects are planets, which means wanderers, as they change their position in the night sky.

There are nine planets in all, including the earth. They have no light of their own, but appear to shine as the sunlight from their surface is reflected. All planets (except Venus) rotate from the west to the east. Due to their different speeds, the position of the planets with respect to the earth changes every day. In Indian astronomy, the planets are called Graha. **Fig. 15.7** shows all planets revolving around the sun.

The list of all the planets in the order of increasing distance from the sun is given below, along with their Hindi names

Name of Planet (in English)	Name of Planet (in Hindi)
1. Mercury	Budha
2. Venus	Shukra
3. Earth	Prithvi
4. Mars	Mangal
5. Jupiter	Brihaspati
6. Saturn	Shani
7. Uranus	Indra or Arun
8. Neptune	Varun
9. Pluto	Yama

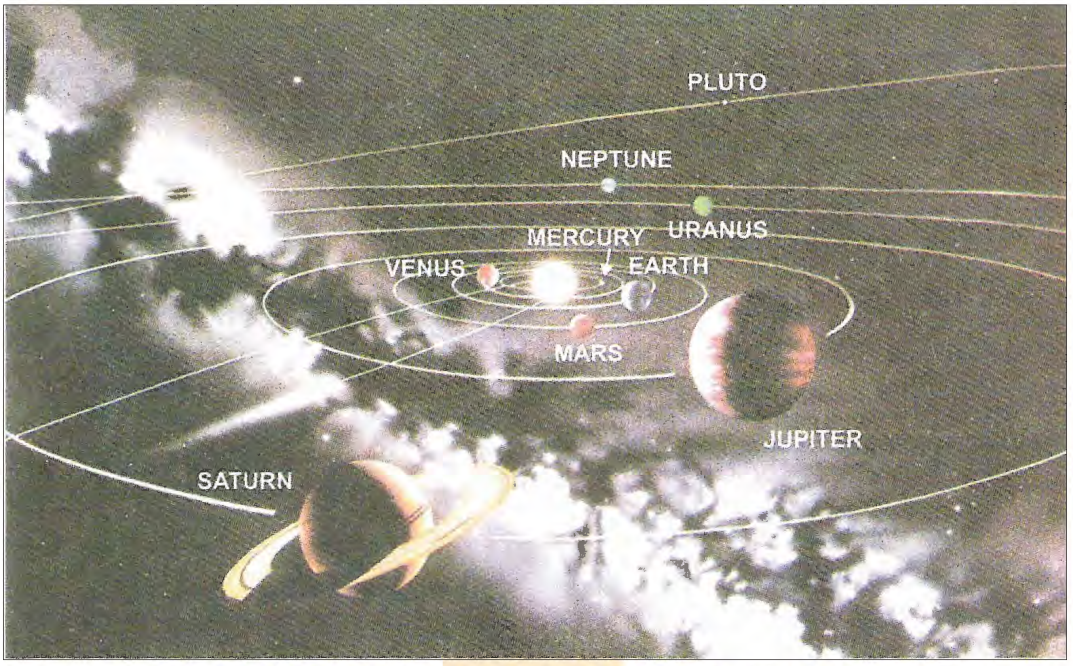

Fig15.7 All Planets Revolve Around the Sun in Elliptical Orbits.
(Note that at some points, the orbit of Pluto fall inside that of Neptune).

Let us study more about the individual planets.

1. Mercury (Budha)

It is the first planet in the solar system and is closest to the sun. Because of its closeness to the sun, it is one of the hottest planets in the solar system.

The surface features of mercury are similar to that of the moon. It has neither water nor atmosphere. Because of its extremely high temperature, lack of water and atmosphere, life is not possible.

As mercury is closest to the sun, it is hidden most of the time in the glare of the sun. However, it is visible just before sunset or just before sunrise. It appears like a bright star in the sky and is commonly called Morning Star or Evening Star. It is visible for 8 weeks just before sunset in the western sky, and then for another 8 week in the eastern sky just before sunrise.

Note: Mercury is a planet and not a star. However, as it the first, which appears in the morning or evening in the sky, it has become customary to call it a star.

2. Venus (Shukra)

It is the second planet from the sun. Except the sun and the moon, it outshines all heavenly bodies and hence, is the brightest and hottest planet. It appears as an evening star just above the western horizon for 292 days. After this, it appears as a morning star for another 292 days in the eastern horizon.

In spite of the fact that venus is second in distance from the sun as compared to mercury, it is brightest, because of cloudy atmosphere of carbon dioxide. This cover reflects more than 3/4th of the sunlight falling on its surface.

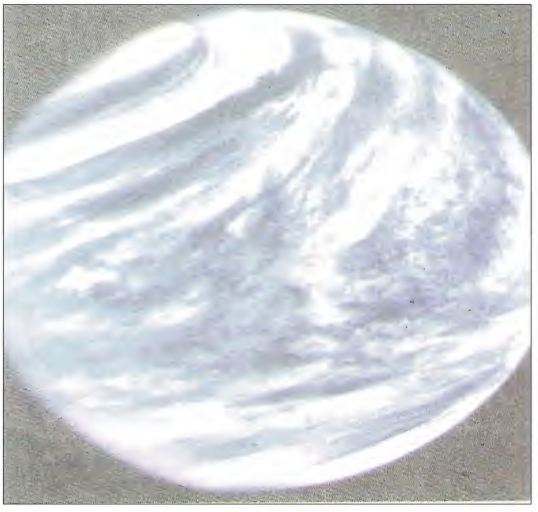

Fig. 15.8 Venus is a planet covered by thick clouds

The mass of Venus is 0.8 times the mass of the earth. However, its size is almost similar to that of the earth. It revolves around the sun in 225 days and rotates around its own axis in 243 days. Thus, in this way, Venus keeps its same face towards the sun. On account of its rotation and revolution, the temperature on its day side rises above 150°C and the temperature of its night side is below 170°C.

The most interesting feature of venus is that it rotates from east to west about its axis, whereas all other planets rotate from west to east about their axis.

It has a thick atmosphere of carbon dioxide, which contributes to its excessive day side temperature. It has no water on its surface. No life is possible on venus on account of the following reasons:

(i) Its day side temperature is too high and night side temperature is too low.

(ii) It has no water to sustain life.

(iii) It has no oxygen in its atmosphere to sustain life.

3. Earth (Prithvi)

Fig. 15.9 A Photograph of the Earth from Space

Earth is the third planet from the sun. It has one natural satellite, the moon. The earth is the only planet in the solar system on which life exists, on account of correct distance from the sun, correct temperature and the presence of air, water and soil.

Size of the Earth

The earth is not a perfect sphere. It is somewhat flattened at the poles and bulging at the equator. The average diameter of the earth is 12,800 km. The circumference of the earth at the equator is 40,000 km approximately. The mass of the earth is estimated to be around 5.98×10^{24} kg. It is surrounded by an atmosphere of 20.9% oxygen, nitrogen 78.03% and other gases 1%. The atmosphere extended to a height of 200 km from the surface of the earth.

The motion of the earth around the sun is called revolution. It revolves around the sun at a distance of 150,000,000 km (approx) in a nearly circular orbit. It takes 365.25 days to complete one revolution around the sun.

The earth spins about its own imaginary axis like a top, from west to east. This motion of earth about its own axis is called motion of rotation. The earth completes one rotation about its own axis in 24 hours.

Formation of day and night on the earth

The sun gives heat and light all the time. This heat and light energy is received by all the planets revolving around it. However, at any time, only half of the earth faces the sun, whereas the other half is opposite to the sun. The half of the earth which receive light has day, whereas the half opposite to the sun has night. However, as the earth steadily moves about its own axis, gradually the day part of the earth moves away from the sun, i.e. towards the night side and vice versa. Thus, days and nights are formed.

Change of Season :

Change of season on the earth takes place due to the following reasons:

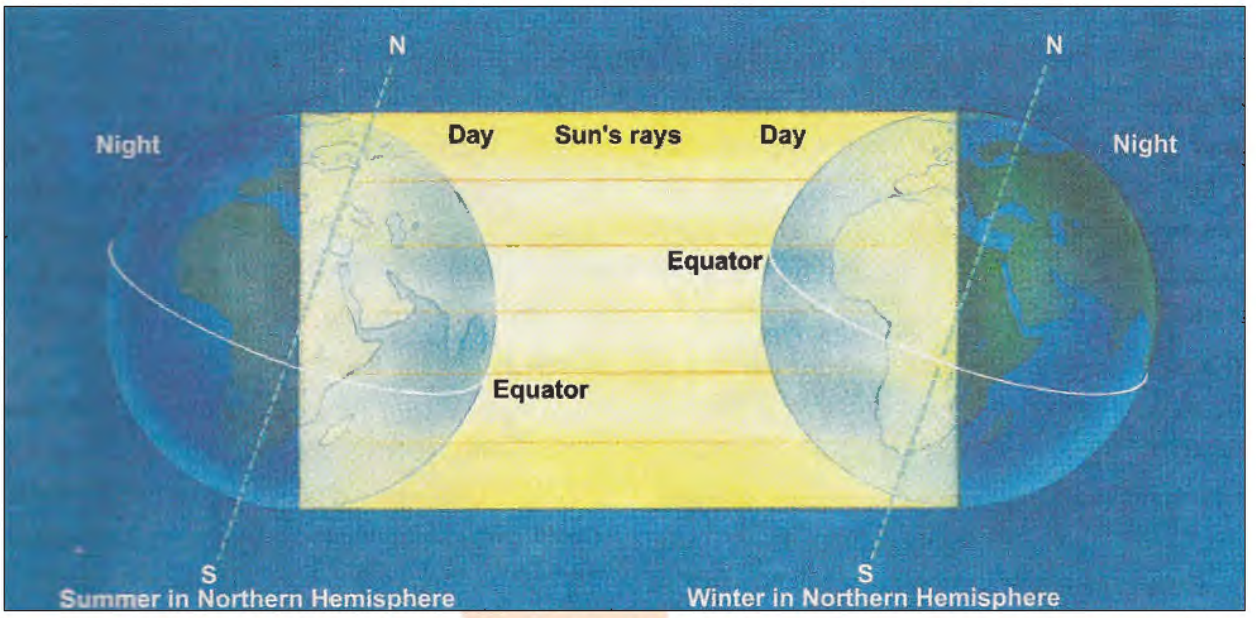

Fig. 15.10 : Earth Tilted About its Axis

(i) The axis of rotation of the earth is tilted at an angle of 23½° with vertical.

(ii) The earth is not always at the same distance from the sun, on account of its slightly elliptical orbit around the sun.

Note in the **Figure 15.10** and **15.11** that the tilted axis rotation of the earth is always in the same direction. Due to this tilt in the axis of rotation, the position of the northern and southern hemispheres of the earth toward the sun, keeps on changing throughout the year.

When the northern hemisphere is tilted towards the sun, we experience summer, whereas the people in the southern hemisphere experience winter. Similarly, autumn and spring occur when the earth is between these two extreme positions in its orbit.

On June 21, the earth is farthest from the sun in the southern hemisphere, but nearest in the northern hemisphere. Thus, on June 21, the northern hemisphere has the longest day, whereas the southern hemisphere has the shortest day. On

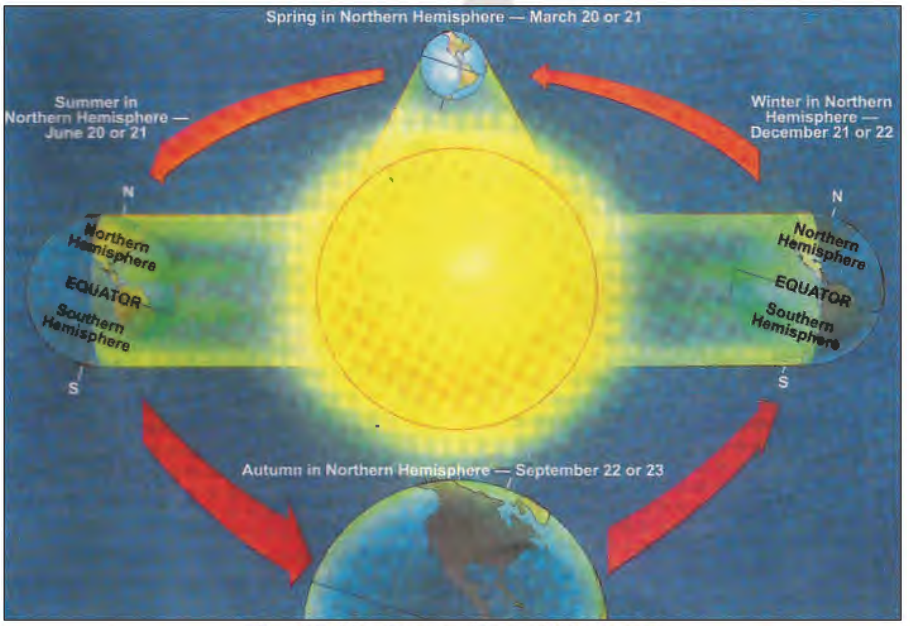

Fig. 15.11 : Formation of Seasons

December 22, the reverse happens, i.e. The northern hemisphere has the shorter day and the sourthern hemisphere has longest day.

On March 21 and September 23, the duration of day and night are equal in both hemispheres. Due to this change in the length of days the mount of heat and light received by the earth changes every day. This in turn gives rise to seasons, such as winter, spring, summer and autumn.

4. Mars (Mangal)

It is the fourth known planet in the order of increasing distance from the sun. To an unaided eye, it appears like a red star and hence it is sometimes called the red planet. The distance of Mars from the sun is 228×10^6 km. It has a diameter of 6794 km. Its mass is $1/9^{th}$ the mass of the earth. It has very thin layer of atmosphere. It rotates about its axis in 1.026 days and revolves around the sun in 687 days (about 2 years). There are two moons revolving around it, namely Photos and Deimos. Both these moons are very close to surface of the Mars and are less than 20 km in diameter.

Fig. 15.12 : View of Mars

It is believed that mars have a large amount of water in the form of ice, near its polar caps. Scientists believe that in the beginning, mars had an atmosphere just like earth. However, owing to its low gravitational pull, gases in its atmosphere escaped, leaving behind a very thin atmosphere. Life on mars could not originate or survive due to the following reasons:

Mars is too cold and the temperature is not right for life to evolve or survive.

It does not have sufficient amount of water and oxygen, so vital for life to survive.

5. Jupiter (Brihaspati or Guru)

It is the fifth planet in the order of increasing distance from the sun. It is the largest planet in the solar system, its mass being more than al the other planets taken together. Its distance from the sun is 778.6×10^6 km i.e. Approximately five times the distance of the sun from the earth. Thus, it receives much less energy from the sun as compared to the first four planets. In spite of the fact that it receives much less solar energy, it happens to be the brightest of the planets in the sky, except for venus and some times mars. It is because, it has a thick atmosphere of hydrogen which reflects most of the sunlight falling on it.

Fig. 15.13 : A Photograph of Jupiter from Space. (Notice the position of the great red spot)

Jupiter rotate about its axis in 0.41 days and revolves around the sun in 11.86 years. The atmosphere as well as the core of this planet mainly consists of hydrogen and helium in gaseous form. Its like regions in the outer atmosphere consists of (i) ammonia gas in crystalline form (ii) methane in gaseous

form. One special feature of this planet is a great red spot which is 30,000 km long and 13,000 km wide. In addition to moons, it has a faint ring around its equatorial plane. Life is not possible on this planet on account of very low temperature and very high gravitational pull.

6. Saturn (Shanl)

It is the sixth planet in the order of distance from the sun, i.e., at a distance of 143.5×10^6 km which is roughly double the distance of jupiter from the sun. It is similar in compensation to the jupiter.

Saturn rotates about its axis in 0.44 days and revolves around the sun in 29.5 years. It is surrounded by three flat rings **(Fig. 15.14)** which consists of rocks whose size may vary from a speck to a few kilometers in diameter. Amongst the rings A, B and C, the ring B is the brightest. It has 30 known moons, the largest being Titan. In fact, Titan is the largest moon in the entire solar system. Life is not possible on Saturn, because of extremely low temperature.

Fig. 15.14 Saturn

7. Uranus (India or Arun)

It is the seventh planet in the order of distance from the sun and the third largest planet in the solar system. It was discovered by an English astronomer, William Herschel, in 1781, with the help of a telescope.

Its distance from the sun is 2872.5×10^6 km, i.e. about twice the distance of saturn from the sun. Its diameter is less than half of that of earth. It rotates about its axis in 0.71 days (17 hr 49 minutes) and revolves around the sun in 84 years. Its atmosphere is found to contain hydrogen and methane. So far 21 satellites or moons have been discovered around it. No life is possible on this planet on account of extremely low temperature.

Fig : 15.15 Uranus - Photograph taken by Voyager Space Craft from a Distance

8. Neptune (Varun)

It is the eighth planet in the order of distance from the sun. It was discovered by Urbain Jean Joseph Leverrier, a French astronomer in 1846, when he observed some disturbance in the orbit of Uranus by some other heavenly body. He was able to calculate the position of this disturber (Neptune), theortically. However, it was first observed by a German astronomer Johann Gottfried Galle in Berlin through a very powerful telescope.

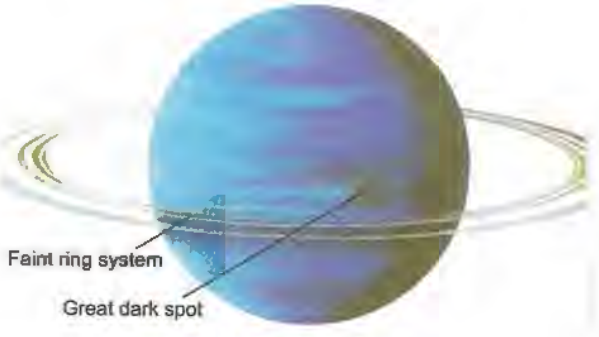

Fig 15.16 : Neptune

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9. Pluto (Yama)

It is the outermost and the smallest planet of the solar system around which revolves a single satellite or the moon.

It was discovered in 1930 by C.W. Tombaugh and was originally thought to be a satellite of Neptune. Later observations proved it as an independent planet.

Its orbit around the sun is not aligned to the orbit of other planets. The most noticeable feature of pluto is that its orbit cuts the orbit of planet neptune.

Its distance from the sun is 5870.0 x 10^6 km, such that sunlight takes over 32 hours to reach this planet. It rotates about its axis in 6.9 days and completes one revolutin around the sun in 248.7 years

SPOTLIGHT

The planets from mercury to neptune have well defined near circular orbits, and revolve around the Sun in the same plane. However, pluto (discovered in 1930) does not revolve around the Sun in same plane as the other 8 planets. In fact its orbit is highly tilted and intersects with the orbit of the

Planet	Distance from Sun	Diameter in Kilometers	Time taken to rotate about its axis	Time taken to revolve around the Sun	Number of Moons
Mercury	57.9 million km	4879 km	59 hours	88 days	Nil
Venus	108.2 million km	12,104 km	243 hours	225 days	Nil
Earth	149.6 million km	12,800 km	24 hours	1 year	1
Mars	228 million km	6794 km	24 hours - 37 minutes	2 year (app.)	2
Jupiter	778.6 million km	1,42,984 km	9 hours - 54 minutes	12 years (app.)	28*
Saturn	1433.5 million km	1,20,500 km	10 hours - 14 minutes	29½ years	30*
Uranus	2872.5 million km	51,118 km	17 hours-49 minutes	84 years	21*
Neptune	4495.1 million km	49,528 km	16 hours-40 minutes	165 years (app)	8*
Pluto	570 million km	3,000 km	6.9 days	248 years (app.)	1

nepture. Nevertheless, pluto was called ninth planet.

This continued till 1992, when astronomers discovered several other objects (some bigger than the pluto) moving around the sun in highly titled orbits, and hence, qualified to be called planets.

Thus, there was a reason to reclassify the pluto and other objects which were found beyond pluto.

In 2006, International Astronomical Union (IAU) empanelled a committee to define : (i) What is a planet ? and (ii) what is the status of pluto and observatory in June 2006 and reached a unanimous agreement. The decision of committee was discussed in Prague at IAU General Assembly of Astronomers of the World.

Following were the decisions of the General Assembly of IAU on 23rd August 2006.

1. A planet is a body in near circular orbit around a star (in our case sun), which is big enough for the force of gravity to make it round and should not take more than 2 centuries to revolve around the Sun.
2. Pluto takes 248 years to revolve around the Sun, so it is disqualified as a planet.
3. Now the Pluto and objects beyond it are called 'plutons', new members of solar family. The order of plutons is (i) pluto (ii) charon, (iii) 2003 UB_{313}.

From August 2006 onward :

(i) There are eight planets revolving around the Sun.

(ii) There are three plutons revolving around the Sun, beyond neptune, in highly tilted orbits.

(iii) Mercury is the nearest planet from the Sun.

(iv) Neptune is the farthest planet from the Sun.

(v) Pluto is the first member of plutons.

(vi) Next to pluto is charon and finally 2003 UB_{313}.

(vii) Plutons have highly tilted orbit and take more than 200 years to revolve around the Sun.

TEST YOURSELF

1. What is a planet ? How many planets revolve around the Sun ?
2. Name the planet which (i) is nearest to the sun (ii) is farthest from the Sun (iii) supports life ?
3. Name the planet which (i) revolves around the sun from east to west (ii) intersects the orbit of another planet ?
4. Name one planet that was predicted before its discovery ?
5. Name the planet having (i) largest number of moons (ii) a system of number of rings ?
6. What is the solar system? Name all the planets of solar system in the increasing order of distance from the sun ?

15.8 The Solar System

Sun is the nearest star for us on the earth. It is believed that the sun was born 5 billion years (500 crore years) ago. It has been emitting a huge amount of heat and light and is expected to do the same for another 5 billion years.

The sun along with the nine planets and their moons constitutes the solar system (refer to **Figure 15.7**). In addition to the planets and their moons, other heavenly bodies have been found to revolve around the sun. They are asteroids, comets and meteors. Let us study more about them.

15.9.1 Asteroids

The small piece of rocks or metal which revolve around the sun, in between the orbits of the mars and jupiter are called asteroids (meaning star like or minor planets).

Asteroids are not visible to the unaided eye, but can be easily seen through a powerful telescope. They are of varying sizes, the largest being Ceres, which is 633 km in diameter. It is estimated that there are around 100,000 asteroids. Each asteroid has its own orbit. In fact the orbits of asteroids are spread over a large distance forming a band.

There are two schools of thought in formation of asteroids.

1. According to one school, these are original rocks and the metal chunks, which failed to form a planet, when other planets were formed in the solar system.
2. According to the second school of thought, they are the debris of a planet which collided with a moon of the Jupiter.

15.9.2 Comets

The bright "star-like", objects with a long tail, approaching the sun in a highly elliptical orbit are called comets.

Fig. 15.17

The bright star-like objects is commonly called the "head of the comet". It consists of frozen water, along with the sun, the ice and the gases along with dust change to form gaseous matter, which appear in the form of long tail. The tail of a comet always points away from the sun, because of the pressure of solar radiations (solar wind).

The tail of the comets could be as long as 800 million kilometers.

The time period of revolution of the comets around the sun is very long. There are some comets which appear after fixed interval of time. Such comets are called periodic comets.

Halley's Comet is one such periodic comet which is visible once in 76 years. It was sighted in 1910 and then in 1986. It is expected to visit us in the year 2062.

Unlike planets, the comets do not last for ever in the solar system. It is because as they approach the sun, they lost a good amount of their mass in the form of gases and small chunks of rocks. Thus, they become smaller and smaller and finally disappear.

15.9.3 Meteors

The bright star-like objects which appear suddenly in the sky and then for a few moments glow with a brilliant white flash of light falling towards the earth and finally disappear are called meteors.

It is believed that meteors are the debris of comets floating in the sky. When a chunk of this debris enters the gravitational field of the earth, it starts falling towards the earth. When it passes through the atmosphere, it becomes white hot on account of friction of the atmosphere. Thus, it catches fire and appears like a brilliant flash of light. Meteors are commonly known as shooting stars, though they are not stars.

15.9.4 Meteorites

If a meteor is too big and fails to burn completely in the atmosphere, then a part of it reaches the surface of the earth.

The unburnt piece of a meteor, which reaches the surface of the earth is called meteorite.

Fig. 15.18 Meteor in Night Sky

Meteorite which reaches the surface of the earth can be of the size of small pebbles to several tones of rock or metal. By studying the composition of meteorites, we have vital information regarding the nature of matter in the space.

The earth receives far less meteorites as compare to the moon. It is because a majority of the meteors burn in the atmosphere of the earth.

However, the moon has no atmosphere. Thus, the meteors directly reach its surface and form meteorites.

DIFFERENCE BETWEEN A STAR AND A PLANET	
Star	**Planet**
1. Stars have their own light	1. Planets do not have their own light.
2. Stars produce their own energy due to the fusion of hydrogen.	2. Planets do not produce their own energy. They have to depend upon the energy of stars (Sun)
3. Stars appear to twinkle at night.	3. Planets do not twinkle at night
4. Stars have enormous mass.	4. Planets have insignificant mass, compared to the stars.
5. Stars do not change their relative position in the sky every day	5. `Planets change their position in the sky on a daily basis.
6. Stars appear to move from east to west in the sky.	6. Planets appear to rotate from the west to east (except venus) in the sky.
DIFFERENCE BETWEEN A STAR AND A SHOOTING STAR (METEOR)	
Star	**Shooting Star (Meteor)**
1. The material of the stars mostly consists of hydrogen and helium	1. The material of a shooting star is mostly made of rocks, metals and dust.
2. Stars produce heat energy and light energy due to the fusion of hydrogen.	2. The shooting stars produce heat energy and light energy due to the friction of the earth's atmosphere
3. Stars are extremely big.	3. The shooting stars are very small pieces of rocks.
4. Stars last for billion of years.	4. The shooting stars last for a few seconds.

KEY Words

Asteroids :	The small pieces of rocks or metals which revolve around the sun, in between the orbits of mars and jupiter.
Celestial Bodies :	Bodies such as the earth, the moon, the planets, the sun, the stars, the comets, etc.
Comets :	The bright "star-like" object with a long tail approaching the sun in a highly elliptical orbit.
Light year :	The distance travelled by light in one year.
Meteorities :	The unburnt pieces of meteor, which reach the surface of the earth.
Meteor :	A bright "Star-like" object which suddenly appears in the sky and then for a few moments streaks in the form of a brilliant flashes towards the earth.
Natural Satellite :	The celestial body/bodies revolving around the planets.
Orbit :	The path along which celestial bodies revolve around the sun or other celestial bodies.
Phases of Moon :	The waxing and waning of the disc of the moon as it revolves around the earth.
Planets :	The celestial bodies which revolve around the sun in well defined orbits.
Pole Star :	A star in line with north pole of the earth, whose position does not change.
Shooting Stars :	Same as meteor.
Stars :	Giant balls of fusing hydrogen or helium which emit huge amount of heat and light.

Exercises

1. Fill in the blanks by choosing correct words from the following list :

List: meteorite, pluto, moon, planets, universe, core, comet, constellation.

(i) The branch of science which deals with the study of _____ is called astronomy.

(ii) The unburnt part of a meteor which reaches the earth is called _____.

(iii) The heavenly bodies which revolve around the sun are called _____.

(iv) The heavenly bodies which revolve around the planets are called _____.

(v) The orbit of _____ is not in the same plane as that of the other planets.

(vi) A heavenly body with along tail, moving around the sun in an elliptical path is called _____.

(vii) In the _____ of the sun, hydrogen gas fuses with the liberation of the energy.

(viii) A group of stars which resembles an animal or some other known object is called _____.

2. Statements given below are incorrect. Write correct statements.

(i) Halley's comet visits our solar system after 26 years.

(ii) Helium gas constitutes most of the atmosphere of the sun and the stars.

(iii) Pole star is nearest to our solar system.

(Iv) Astronomers have divided the sky into 68 constellations.

(v) Meteors on burning leave behind gold dust and light.

(vi) The orbit of neptune is different from the orbits of the other planets in the solar system.

(vii) Mars is the second planet nearest to the sun.

(viii) Moon revolves around the earth in 21½ days.

3. Answer the following questions :

(i) What is universe ? Name six different kinds of heavenly bodies found in the universe ?

(ii) With the reference to the average distance from the sun, state : (a) the serial number of the planet earth (b) the average distance of the earth from the sun (c) the time in which the sunlight reaches the earth ?

(iii) (a) Name the natural satellite of the earth ?

(b) In how many days does this satellite complete one revolution around the earth ?

(c) In how many days does this satellite rotate around its own axis ?

(d) How does the gravity of this satellite compare with the earth ?

(e) State the maximum temperature on the day side and minimum temperature on the night side of this satellite ?

(iv) What do you understand by the following terms (a) New Moon (b) Full Moon ?

(v) (a) Define solar system ?

(b) Name all the planets in the solar system in the order of their distance from the sun ?

(vi) (a) How many moons mars have ?

(b) Write the name of these moons ?

(vii) What is comet ? Why does a comet develop a tail while approaching the sun ?

(viii) What is star ? What makes the star give about vast amount of energy ?

(ix) (a) How are meteors different from stars ?

(b) How are meteors different from meteorites ?