

### **Celestial bodies**

- The Universe includes all the stars, planets and galaxies, and its size is unknown.
- However, a spherical region of the Universe can be observed from the Earth, which is called the Observable Universe.
- This Observable Universe comprises different physical objects that occur naturally on their own. These objects are called celestial objects.
- For example, the Sun, the Moon, the stars and the planets in our solar system all are called celestial objects.

### **Astronomy**

Astronomy is the study of celestial objects and the phenomena associated with them. It is said to be one of the oldest Sciences in the world.

It is associated with the study of the evolution of the Universe, the motion of the celestial objects and their formation.

In ancient times, astronomers used to study the sky and observe its changes at night time. With these methodological observations, they used to devise calendars.

They also help in predicting the climate of a place and the rainfall patterns.

These interpretations are used to help the farmers choose the right crops for a certain season and find the right time to sow the seeds.

Their interpretations also help in deciding various festivals in India and the occurrence of seasons.

Nowadays, some computers help in methodological observations of the sky.

### **The Moon**

We know that the Moon is a natural satellite of the Earth that revolves around the Earth in a fixed orbit.

Just like the Earth, other planets of the solar system also have their moons or natural satellites.

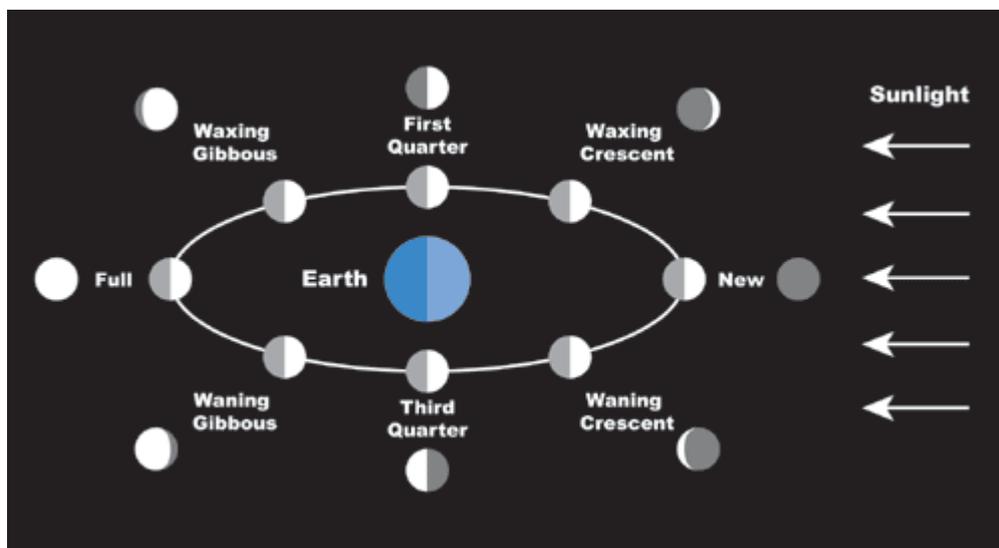
Also, the Moon does not emit any light of its own, but it reflects the Sun's light that falls on it.

However, as the Moon revolves around the Earth, the part of the Moon that faces the Sun gets to light up while the other part remains in the dark.

This results in different shapes of the Moon in the sky.

These shapes of the lit part of the Moon are called the 'Phases of the Moon'.

## The Phases of the Moon



### Phases of the Moon

The phases of the Moon repeat themselves after every 29 days, and there are eight major moon phases.

The day when we can see the whole Moon in the sky is called a '**Full Moon Day**'. On this day, this sunlight falls all over the Moon.

Now, as the Moon revolves and changes its position, the part which receives sunlight starts to decrease, and the Moon appears as if it is getting thinner.

On the 15th day after a Full Moon, the Moon becomes completely invisible as no light of the Sun falls over it due to its position behind the Earth. This is called a '**New Moon Day**'.

The next day the Moon that appears in the sky is called '**Crescent Moon**'.

From this day, the Moon starts growing larger until the 15th day when it reaches its full shape, that is, the Full Moon Day comes.

**The waning phase of the Moon** is the phase of the Moon in which it decreases in size.

**The waxing phase of the Moon** is the phase of the Moon in which it increases in size.

**Blue Moon** – Generally, there occurs one New Moon every month. However, at times, there can be two new moons in a single month. The second New Moon in a month is called the Blue Moon.

The phases of the Moon hold an importance in the Indian society and culture as different festivals in India are celebrated depending upon the Phases of the Moon.

### **The surface of the Moon**

The surface of the Moon is barren and all covered with dust.

There are Craters or bowl-shaped cavities present on the surface of the Moon.

There are steep and high mountains present in huge numbers on the Moon.

Some of the mountains are as high as the highest mountains found on the Earth.

There is no presence of water and atmosphere on the Moon.

### **Can we hear sound on the Moon?**

There is no atmosphere on the Moon. No gases are present on the Moon that could act as a medium for the propagation of sound. Hence, the astronauts of the Moon cannot hear each other. They generally use signs or microphones to communicate with each other.

### **Who was the first Astronaut to land on the Moon?**

Neil Armstrong was the first person to land on the Moon, followed by another Astronaut Edwin Aldrin. Neil Armstrong landed on the Moon on July 21, 1969.

### **What is a lunar eclipse?**

The lunar eclipse occurs when the Moon, the Earth, and the Sun are very closely aligned. The Earth is present exactly in the middle of the Moon and the Sun.

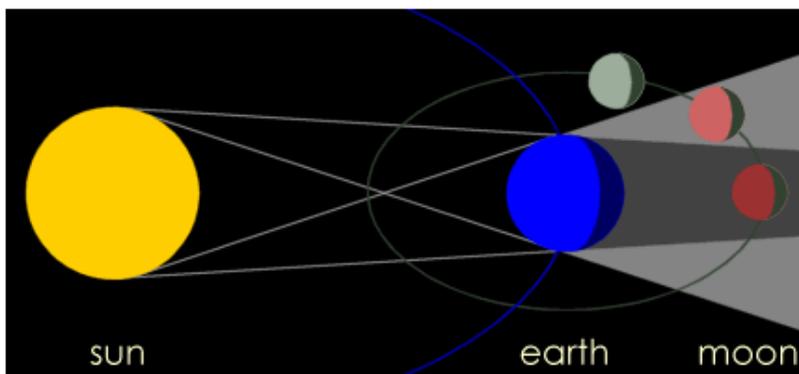
Hence, the shadow of the Earth falls upon the Moon.

Therefore during the lunar eclipse, the Moon does not reflect the light of the Sun but the light that it receives from the Earth.

As a result, the Moon appears reddish during a lunar eclipse.



Surface of the Moon



## Lunar Eclipse

### The Stars

The stars are celestial bodies comprising of hot gases (mainly helium and hydrogen).

All the stars emit their light.

All the stars are not the same. They may vary in brightness, size, colours and temperature.

They are massive in size; however, they appear as point-sized objects from the Earth's surface.

This is so because they are at a huge distance from the Earth.

Stars have a life period. They take millions of years to be born and live for tens of millions of years and eventually come to an end. Due to their long lifespan, the changes in the stars are not very sudden. Hence, they **appear permanent** to us.

### Why do stars twinkle?

Stars emit light that has to travel through the layers of the Earth's atmosphere when entering the earth surface. Hence, it appears that the light is travelling in a zig-zag motion due to the change in densities of the Earth's atmosphere and the density of the space. Therefore, it appears to us as if the stars are twinkling.

### Why Sun is a Star?

The Sun is also a star because the Sun can produce heat and light energy on its own.

The Sun has a life period just like every other star.

The Sun is estimated to have been born around 5 billion years ago and live for the next 5 billion years.

### Distance between the Sun and the Earth

The Sun does not appear as a point-sized object like other stars because the Sun is close to the Earth compared to other stars.

The distance between the Earth and the Sun is estimated to be 150,000,000 km.

The star that is closer to the Earth, after the Sun, is called **Alpha Centauri**. The distance between the Earth and the Alpha Centauri is estimated to be 40,000,000,000,000 km.

## **Light Year**

The distance between celestial objects is described in light-years.

As the name suggests, a light-year is the total distance light travels in 1 year.

The speed of light = 300,000 km per second

The distance between the Sun and the Earth = 8 light minutes

The distance between Alpha Centauri and the Earth = 4.3 light-years

## **Why are stars invisible during the daytime?**

Stars are present in the sky during the day as well as at night time. However, the sunlight is so bright during the daytime that it becomes difficult to locate stars in the sky.

## **Can stars change their positions?**

If we observe a star or a group of stars for some hours, their position appears to change. This is because of the motion of the Earth. The Earth keeps on revolving around the Sun and hence changes its position with respect to the stars.

## **Why do stars appear moving from east to west?**

The rotation of the Earth takes place in a direction from west to east. It appears as if the Earth is still and the sky is moving from east to west direction. However, it is not true. Also, this is the same reason why the Sun appears to rise from the east and set in the west.

## **The significance of the Pole Star**

The pole star, also called Polaris, is situated close to the Earth's axis of rotation. As a result, the position of the pole star appears to be fixed. This is unlike the other stars as their position keeps on changing with respect to the Earth.



## Pole Star

### Constellations

A constellation is described as a group of stars that form a recognizable shape or pattern.

Ancient people used constellations as a way to recognize the stars.

The shape of the constellations generally resembles with objects that ancient people used.

There are not only 5 to 10 stars in a constellation.

A constellation comprises several stars, but only some of them, the brightest, can be viewed.

The stars that make up a constellation are found in the same line of sight; however, the distance between these stars is not the same.

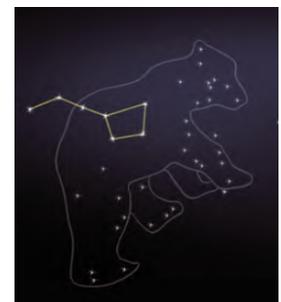


**A constellation**

### Major Constellations

#### 1. Ursa Major or the Great Bear or Saptarishi or the Big Dipper

- This constellation comprises seven major stars.
- These stars form the shape of a big question mark or a ladle.
- The handle of the ladle is made by joining the three stars in a row, and the remaining four stars are in the shape of the bowl of the ladle.



### Ursa Major

#### Significance of Saptarishi

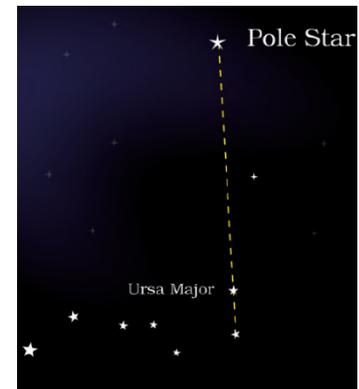
The seven stars in the Ursa Major constellation are believed to signify **seven saints** according to Indian mythology. These seven Saints are believed to preserve the knowledge of the Vedas that they propagate to people in every new age.



## Saptarishi

### How can we locate a pole star using Ursa Major?

- The Ursa Major constellation includes two stars called Merak and Dubhe.
- If we draw an imaginary line from Merak to Dubhe and extend further in the same direction, the first bright star that we would come across is the pole star.
- The pole star is located above the northern hemisphere, and hence it cannot be seen through the southern hemisphere.
- Similarly, many constellations of the northern hemisphere can't be located from different points of the southern hemisphere.



Locating Pole Star using Ursa Major

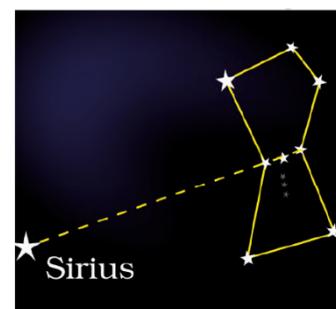
### 1. Orion or the Hunter

- It is one of the most magnificent constellations of the sky.
- It comprises 7 or 8 bright stars.
- There are three stars in the middle that appear as the belt of a hunter.
- The remaining four stars are arranged in the form of a quadrilateral.



### Sirius Star

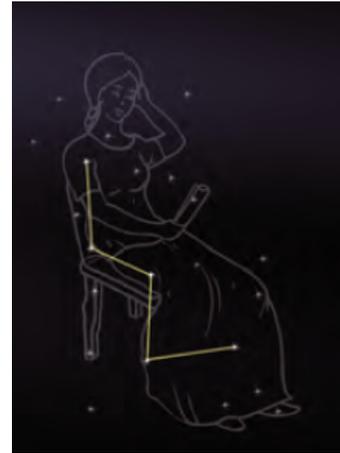
- The Sirius Star is the brightest in the sky.
- It can be located with the help of the Orion constellation.
- If we draw an imaginary line through the three stars in the middle of the Orion and extended further, we will reach the the brightest star, Sirius. Orion



Locating Sirius Star using

## 2. Cassiopeia

- It is a constellation found in the Northern hemisphere and can be located in the sky during the winter season at the beginning of the night.
- The shape of this constellation resembles with a W or distorted.
- The name of this constellation was given after queen Cassiopeia in Greek mythology.

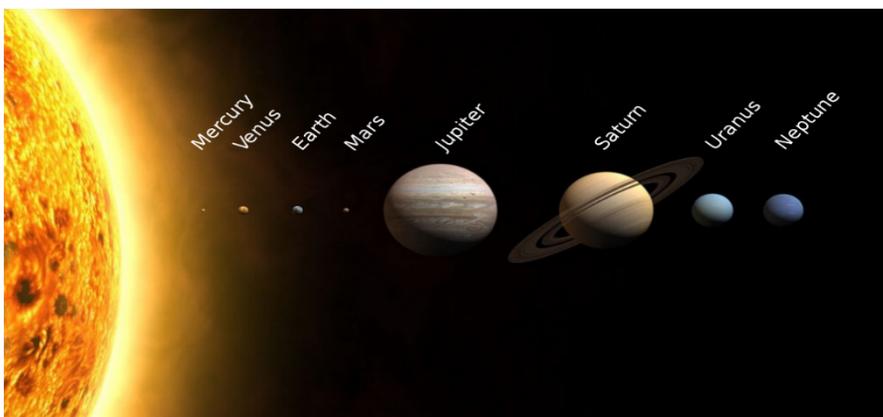


## 3. Leo Major

- It consists of several bright stars, and that is why it can be easily located in the sky.
- It can be viewed from the Northern hemisphere (January to June) as well as Southern hemispheres (summer and autumn).
- The Leo appears upside down from the southern hemisphere.
- It is one of the oldest constellations that were recognized almost 6000 years ago.
- This constellation signifies the Adventures of Hercules.



## The Solar System

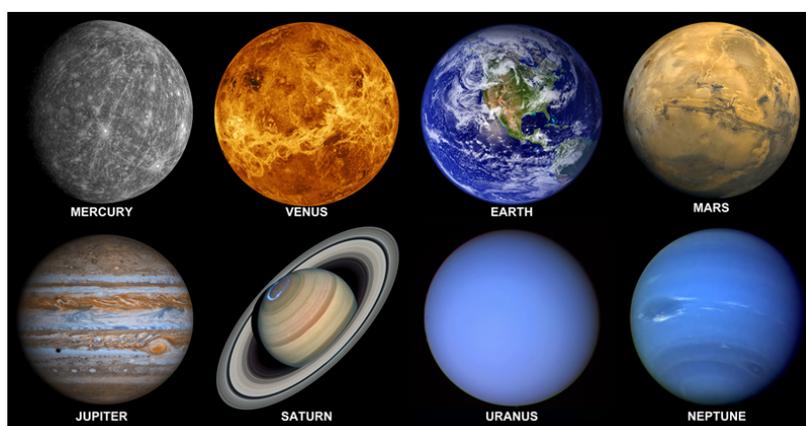


## The Solar System

The Solar System comprises the Sun, the planets, asteroids, meteors and other celestial bodies. A gravitational attraction between the Sun and the celestial objects keeps them revolving around the Sun.

The Sun acts as the main source of heat and light energy for all the planets in the solar system.

### The Planets



### Planets

Our solar system comprises eight planets: **Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune**. The planets do not have their light. They can reflect the light of the Sun that falls upon them.

The planets revolve around the Sun in a fixed path called

The **period of revolution** of a planet is when it takes to complete one revolution around the Sun. As the distance between the Sun and the planets increases, the period of revolution of that planet also increases.

All the planets also revolve around their axis. The **time of rotation** of a particular planet is defined as the time it takes to complete one rotation.

The planets have satellites or celestial objects that revolve around them.

For example, the Moon is a natural satellite of the Earth. However, there are different artificial satellites also that revolve around a planet.

### **Why do planets not fall into the Sun?**

We know that the Sun exerts a gravitational force on all the planets. But they do not fall into the Sun because they revolve around the Sun in a fixed path. This revolution prevents them from falling off into the Sun.

### **Mercury**

- It is the planet that lies closest to the Sun.
- It is the smallest of all the planets.
- It is difficult to observe Mercury because it hides in the glare of the Sun.
- Therefore it can only be observed or viewed in the sky just before the sunset or before the Sunrise.
- It has no natural satellite of its own.

### **Venus**

- It is the brightest planet.
- It can sometimes be viewed in the eastern sky before the Sunrise or in the western sky before the sunset. Hence it is often called morning or evening star.
- It has no natural satellite of its own.
- Venus rotates from east to west, unlike the Earth, which rotates from west to east.
- Venus also shows phases just like the Moon.

### **Earth**

- Life exists only on Earth.
- The Earth has favourable environmental conditions such as the presence of atmosphere and water that enable life on the Earth.
- The temperature conditions of the Earth are also favourable for the existence of life because it is at a perfect distance from the Sun.
- The Earth possesses a **tilted axis** which results in changing of seasons on the Earth.
- The Earth is covered with water naturally and therefore appears bluish-green when viewed from space. The Earth possesses its natural satellite - the Moon.

## Orbital and Equatorial Plane of the Earth

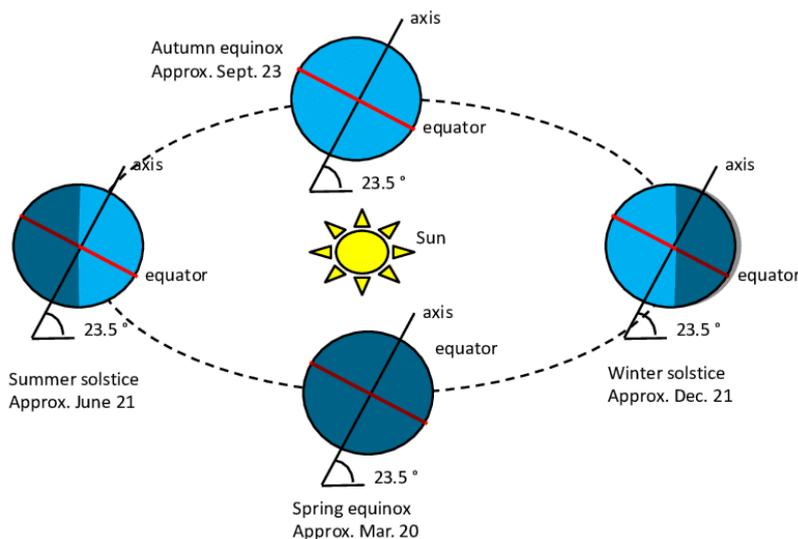
### Orbital Plane of the Earth

We know that Earth revolves around the Sun in orbit. The plane in which it revolves around the Sun is called its orbital plane.

### Equatorial Plane of the Earth

The Equator is an imaginary line drawn from the middle of the Earth. The plane of the Equator is called the equatorial plane.

The equatorial plane and the orbital plane of the Earth are inclined at an angle of  $23.5^\circ$ . Hence, the axis of the Earth is tilted at an angle of  $66.5^\circ$  to the orbital plane.



## Change in Seasons Due to Earth's tilted axis

### Mars

- It is called the Red Planet because it has a reddish colour.
- It has two moons of its own.

### What is Mangalyaan?

Mangalyaan is an Orbiter launched by ISRO (Indian Space Research Organisation) that orbits around Mars. It was launched in November 2013 and successfully placed in its orbit around Mars in September 2014. India is the first country that could place an orbital in its orbit in the first attempt.

## **Jupiter**

- It is the largest planet in the solar system. It can comprise 1300 Earth-like planets.
- It does not have a high mass as compared to its size. The mass of Jupiter is almost 318 times the mass of the Earth.
- The rotation time of Jupiter is small, around 9 hours 55 minutes.
- Jupiter has many moons, out of which four large moons can be viewed from the Earth with the help of a telescope.
- Jupiter has thin rings around it.

## **Saturn**

- Saturn has thick rings around it that can be easily viewed with naked eyes.
- It has 30 natural satellites of its own.
- The density of Saturn is less than that of water, making it the least dense planet of the solar system.

## **Uranus**

- Just like Venus, Uranus rotates from east to west.
- It has 21 natural satellites.
- The rotation axis of the Uranus is highly tilted.
- The atmosphere of Uranus comprises hydrogen and methane gas mainly.

## **Neptune**

- It is the farthest planet from the Sun; hence it takes the most time to revolve around the Sun. It has eight natural satellites of its own.

*Planetary Data Table*

Planet	Average distance from sun (km)	Diameter (km)	Period of revolution (Earth days or years)	Period of rotation (Earth days or hours)
Mercury	58,500,000	4,879	88.0 days	59.9 days
Venus	108,000,000	12,104	224.7 days	244 days
Earth	150,000,000	12,756	365.2 days	1.00 days
Mars	228,000,000	6,794	687.0 days	1.03 days
Jupiter	780,000,000	142,984	11.9 years	9.9 hours
Saturn	1,431,000,000	120,536	29.5 years	10.7 hours
Uranus	2,880,000,000	51,118	83.8 years	17.2 hours
Neptune	4,510,500,000	49,528	163.8 years	16.1 hours

Period of Rotation, Revolution and Distance of all the Planets

## Inner and Outer Planets

The first four planets of the solar system are called **inner planets**. These planets have few moons of their own. The planets after Mars are called the **outer planets** of the solar system. All these planets have a ring system around them and possess a large number of moons.

What are the differences between stars and planets?

**BASIS FOR COMPARISON**

**STARS**

**PLANETS**

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objects, that emit their own light, produced due to thermonuclear fusion, occurring

celestial object that has a fixed path (orbit), in which it moves around the

## Differences between stars and planets

### Other Members of the Solar System

#### Asteroids

- Like other planets, certain celestial bodies are found in the solar system. Asteroids are small rock-like objects that are found orbiting the Sun.
- They are generally found between the orbits of Mars and Jupiter. This region is also called the **Asteroid belt**. However, asteroids can also be found in other places in the solar system.

## Comet

- Comets are big pieces of ice and rock that also revolve around the Sun in elliptical-shaped orbits.
- Comets are the leftover pieces of rocks that were formed at the time when the solar system was beginning its formation.
- Comets are often observed to have a **tail**. This tail appears as a comet approaches the Sun.
- At that time, dust and gas are discharged from the comet due to the heat of the Sun. Since the comet is approaching the Sun, the comet's tail is always in the opposite direction of the Sun.
- As the distance between the Sun and the comet increases, the size of the comet's tail also increases.
- Since comets revolve around the Sun, they can be viewed at periodic times from the Earth.
- For example, **Halley's Comet** appears after every 76 years. It was last viewed in 1986.



**A comet**

## Meteoroids and Meteors

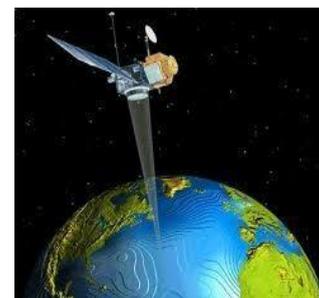
- The asteroids in space sometimes collide with each other and form meteoroids. Hence the small pieces of an asteroid can be called meteoroids.
- From these meteoroids, **meteors** are formed.
- When a meteoroid enters the atmosphere of the Earth, it appears as a **streak of light** in the sky or a meteor. The Meteors generally have high speed as they enter the atmosphere. Thus, they get heated up due to the friction of the atmosphere.
- Hence the meteors light up as a streak of light. However, they evaporate in the sky before reaching the Earth's surface. This streak of light is therefore visible for a short time span only.
- Meteors are also called **shooting stars** because of their characteristic feature. However, they are not stars but just a piece of rock.
- Meteor **Shower**

When the Earth crosses a comet's tail, many flying meteors can be observed in the sky. This is called a Meteor shower. Certain meteor showers occur periodically in the sky.

## Artificial satellites

These are the man-made satellites that are sent out into space to revolve around the Earth. They orbit nearer to the Earth as compared to the Moon. Functions of artificial satellites:

1. Weather forecasting
2. Transmission of signals of radio and television
3. Remote-sensing - acquiring information about an object from a distance, for example, the artificial satellite can acquire information about the Earth from a distance
4. Telecommunication - transmission of information by means of radio signals and electromagnetic systems.



## Some Indian Artificial Satellites of the Earth:

1. Aryabhata
2. INSAT
3. IRS
4. Kalpana-1
5. EDUSAT

## How is an artificial satellite different from a natural satellite?

Artificial Satellites	Natural Satellites
They are formed and controlled by humans.	They are formed naturally.
They are not permanent.	They are permanent.
They can be used to send and receive signals from the Earth.	They cannot be used for communication or sending signals from the Earth.

