



## NATURE OF UNIVERSE

### Building block of the Universe:

The basic constituent of the universe is luminous matter i.e., galaxies which are really the collection of billions of stars. The universe contains everything that exists including the Earth, planets, stars, space, and galaxies. This includes all matter, energy and even time.

The observable universe is around 93 billion light years (1 light year = the distance that light travels in one year, which is  $9.4607 \times 10^{12}$  km) across.

All the atoms together only make up around four percent of the universe. The majority of the universe consists of something scientists call dark matter and dark energy.

It is still expanding today. Over the next three minutes, the temperature dropped below 1 billion degrees Celsius. After 300 000 years, the Universe had cooled to about 3000 degrees. Atomic nuclei could finally capture electrons to form atoms. At that stage of the evolution of the Universe, it was filled with clouds of hydrogen and helium gas. Giant clouds of hydrogen and helium were gradually drawn to the places where dark matter was most dense, forming the first galaxies, stars, and everything else seen today.

### Galaxies:

A galaxy is a massive collection of gas, dust, and billions of stars and their solar systems. Scientists believe that there are one hundred billion ( $10^{11}$ ) galaxies in the observable universe.

Immediately after the Big Bang, clouds of gases began to compress under gravity to form the building blocks of galaxies.

## **Milky Way:**

The Milky Way is the galaxy in which our solar system is located. The Milky Way includes stars smaller than our Sun as well as many other stars that are thousands of times bigger than the Sun.

The galaxy that is closest to our Milky Way is Andromeda. In Indian mythology, this patch called as Akasha Ganga.

Tucked inside the very center of the galaxy is a monstrous black hole, billions of times as massive as the sun. Although, black holes cannot be directly viewed, scientists can see their gravitational effects as they change and distort the paths of the material around it.

## **Constellation:**

A constellation is a recognizable pattern of stars in the night sky when viewed from the Earth. International Astronomical Union has classified 88 constellations to cover the entire celestial sphere.

Ursa Major (Saptha Rishi Mandalam) is a large constellation and it covers a large part of the sky. The most striking feature of this constellation is a group of seven bright stars known as big dipper (seven Sages in Indian astronomy).

Different constellations become visible in the sky at different times in the year. This happens due to the revolution of the Earth around the Sun. Unlike galaxy, constellations are mere optical appearance and not real objects.

People in different cultures and countries adopted their own sets of constellation outlines. There are 88 formally accepted constellations. Aries, Gemini, Leo, Orion, Scorpius and Cassiopeia are some of the constellations.

## **Stars :**

Stars are the fundamental building blocks of galaxies. Stars produce heat, light, ultraviolet rays, x-rays, and other forms of radiation. They are largely composed of gas and plasma (a superheated state of matter). Stars are built by hydrogen gases. Hydrogen atoms fuse together to form helium atoms and in the process they produce large amount of heat.

Stars also appear to be in different colours depending on their temperature. Hot stars are white or blue, whereas cooler stars are orange or red in colour. They also occur in many sizes.

## The Solar System:

It consists of large number of bodies such as planets, comets, asteroids and meteors. The gravitational force of attraction between the Sun and these objects keep them revolving around it.

The Sun is a medium sized star, a very fiery spinning ball of hot gases. Three quarters of the Sun has hydrogen gas and one quarter has helium gas. It is over a million times as big as the Earth. Sun is believed to be more than 4.6 billion years old.

## Planets:

A planet revolves around the Sun along a definite curved path which is called an orbit. It is elliptical. The time taken by a planet to complete one revolution is called its period of revolution. Besides revolving around the Sun, a planet also rotates on its own axis like a top. The time taken by a planet to complete one rotation is called its period of rotation. The period of rotation of the Earth is 23 hours and 56 minutes and so the length of a day on Earth is taken as 24 hours.

The four planets grouped together in the inner solar system are Mercury, Venus, Earth and Mars. They are called inner planets. They have a surface of solid rock crust and so are called terrestrial or rocky planets. Their insides, surfaces and atmospheres are formed in a similar way and form similar pattern.

The four large planets Jupiter, Saturn, Uranus and Neptune spread out in the outer solar system and slowly orbit the Sun are called outer planets. They are made of hydrogen, helium and other gases in huge amounts and have very dense atmosphere. They are known as gas giants and are called gaseous planets.

**Mercury:** Mercury is a rocky planet nearest to the Sun. It is very hot during day but very cold at night. Mercury can be easily observed thorough telescope than naked eye since it is very faint and small. It always appears in the eastern horizon or western horizon of the sky.

**Venus:** Venus is a special planet from the Sun, almost the same size as the Earth. It is the hottest planet in our solar system. After our moon, it is the brightest heavenly body in our night sky. This planet spins in the opposite direction to all other planets. So,

unlike Earth, the Sun rises in the west and sets in the east here. Venus can be seen clearly through naked eye. It always appears in the horizon of eastern or western sky.

**The Earth:** The Earth where we live is the only planet in the solar system which supports life. Due to its right distance from the Sun it has the right temperature, the presence of water and suitable atmosphere and a blanket of ozone. All these have made continuation of life possible on the Earth. From space, the Earth appears bluish green due to the reflection of light from water and land mass on its surface.

**Mars:** The first planet outside the orbit of the Earth is Mars. It appears slightly reddish and therefore it is also called the red planet. It has two small natural satellites (Deimos and Phobos).

**Jupiter:** Jupiter is called as Giant planet. It is the largest of all planets (about 11 times larger and 318 times heavier than Earth). It has 3 rings and 65 moons. Its moon Ganymede is the largest moon of our solar system.

**Saturn:** Known for its bright shiny rings, Saturn appears yellowish in colour. It is the second biggest and a giant gas planet in the outer solar system. At least 60 moons are present - the largest being Titan. Titan is the only moon in the solar system with clouds. Having least density of all (30 times less than Earth), this planet is so light.

**Uranus:** Uranus is a cold gas giant and it can be seen only with the help of large telescope. It has a greatly tilted axis of rotation. As a result, in its orbital motion it appears to roll on its side. Due to its peculiar tilt, it has the longest summers and winters each lasting 42 years

**Neptune:** It appears as Greenish star. It is the eighth planet from the Sun and is the windiest planet. Every 248 years, Pluto crosses its orbit. This situation continues for 20 years. It has 13 moons - Triton being the largest. Triton is the only moon in the solar system that moves in the opposite direction to the direction in which its planet spins.

**Asteroids:** There is a large gap in between the orbits of Mars and Jupiter. This gap is occupied by a broad belt containing about half a million pieces of rocks that were left over when the planets were formed and now revolve around the Sun. These are called asteroids. The biggest asteroid is Ceres - 946 km across. Every 50 million years, the Earth is hit by an asteroid nearing 10 km across. Asteroids can only be seen through large telescope.

**Comets:** are lumps of dust and ice that revolve around the Sun in highly elliptical orbits. Their period of revolution is very long. When approaching the Sun, a comet

vaporizes and forms a head and tail. Some of the biggest comets ever seen had tails 160 million (16 crores) km long. This is more than the distance between the Earth and the Sun. Many comets are known to appear periodically. One such comet is Halley's Comet, which appears after nearly every 76 years. It was last seen in 1986. It will next be seen in 2062.

**Meteors and Meteorites:** Meteors are small piece of rocks scattered throughout the solar system. Traveling with high speed, these small pieces come closer to the Earth's atmosphere and are attracted by the gravitational force of Earth. Most of them are burnt up by the heat generated due to friction in the Earth's atmosphere. They are called meteors. Some of the bigger meteors may not be burnt completely and they fall on the surface of Earth. These are called meteorites.

## **SATELLITES:**

**Satellites** A body moving in an orbit around a planet is called satellite. In order to distinguish them from the man made satellites (called as artificial satellites), they are called as natural satellites or moons. Satellite of the Earth is called Moon (other satellites are written as moon). We can see the Earth's satellite Moon, because it reflects the light of the Sun. Satellite moves around the planets due to gravity, and the centripetal force. Among the planets in the solar system all the planets have moons except Mercury and Venus.

## **Orbital Velocity:**

We saw that there are natural satellites moving around the planets. There will be gravitational force between the planet and satellites. At this altitude, the friction due to air is negligible. The satellite is carried by a rocket to the desired height and released horizontally with a high velocity, so that it remains moving in a nearly circular orbit.

The horizontal velocity that has to be imparted to a satellite at the determined height so that it makes a circular orbit around the planet is called orbital velocity.

Orbital velocity can be calculated using the following formula.

$$V = \sqrt{\frac{GM}{(R+h)}}$$

where, G = Gravitational constant ( $6.673 \times 10^{-11}$  Nm<sup>2</sup> kg<sup>-2</sup>)

M = Mass of the Earth ( $5.972 \times 10^{24}$  kg)

R = Radius of the Earth (6371 km)

$h$  = Height of the satellite from the surface of the Earth.

Time taken by a satellite to complete one revolution round the Earth is called time period.

## Universe Part - 2

### Rockets:

Space research provides information to understand the environment of the earth and the changing climate and weather on the earth. Exploring the space will help us to answer many of the challenges we are facing these days. Discovery of rockets has opened a small portion of the universe to us.

Rockets help us to launch space probes to explore the planets in the solar system. They also help us to launch space-based telescopes to explore the universe.

### Parts of Rockets

There are four major parts or systems in a rocket. They are:

- Structural system
- Payload system
- Guidance system
- Propulsion system

### Structural system (Frame)

The structural system is the frame that covers the rocket. It is made up of very strong but lightweight materials like titanium or aluminium. Fins are attached to some rockets at the bottom of the frame to provide stability during the flight.

### Payload system

Payload is the object that the satellite is carrying into the orbit. Payload depends on the rocket's mission. The rockets are modified to launch satellites with a wide range of missions like communications, weather monitoring, spying, planetary exploration, and as observatories. Special rockets are also developed to launch people into the Earth's orbit and onto the surface of the Moon.

### Guidance system

Guidance system guides the rocket in its path. It may include sensors, on-board computers, radars, and communication equipment's.

## **Propulsion system**

It takes up most of the space in a rocket. It consists of fuel (propellant) tanks, pumps and a combustion chamber. There are two main types of propulsion systems. They are: liquid propulsion system and solid propulsion system.

## **Types of Propellants:**

A propellant is a chemical substance that can undergo combustion to produce pressurized gases whose energy is utilized to move a rocket against the gravitational force of attraction. It is a mixture, which contains a fuel that burns and an oxidizer, which supplies the oxygen necessary for the burning (combustion) of the fuel. The propellants may be in the form of a solid or liquid.

## **Liquid propellants**

In liquid propellants, fuel and oxidisers are combined in a combustion chamber where they burn and come out from the base of the rocket with a great force. Liquid hydrogen, hydrazine and ethyl alcohol are the liquid fuels. Some of the oxidizers are oxygen, ozone, hydrogen peroxide and fuming nitric acid.

## **Solid propellants:**

In solid rocket propellants, fuel and oxidiser compounds are already combined. When they are ignited, they burn and produce heat energy. Combustion of solid propellants cannot be stopped once it is ignited. Solid fuels used in rockets are polyurethanes and poly butadiene's. Nitrate and chlorate salts are used as oxidizers.

## **Cryogenic propellants:**

In this type of fuel, the fuel or oxidizer or both are liquefied gases and they are stored at a very low temperature. These fuels do not need any ignition system. They react on mixing and start their own flame.

## **Launching of Satellite:**

Before being launched into the space, rockets will be held down by the clamps on the launching pad. When the fuel in the rocket is burnt, it will produce an upward thrust. There will be a point at which the upward thrust will be greater than the weight of the satellite. At that point the clamp will be removed by remote control and the rocket will move upwards. According to Newton's third law, for every action there is an equal and opposite reaction. As the gas is released downward, the rocket will move upward.

To place a satellite in a particular orbit, a satellite must be raised to the desired height and given the correct speed and direction by the launching rocket. If this high velocity is given to the rocket at the surface of the Earth, the rocket will be burnt due to air friction. Moreover, such high velocities cannot be developed by a single rocket. So, multistage rockets are used.

### **India's Space Programmes:**

Soon after independence, India initiated space research activities. In 1969, Indian Space Research Organisation (ISRO) was formed with the objective of developing space technology and its application for different needs of the nation.

India is focusing on satellites for communication and rem sensing, space transportation systems and application programmes. The first ever satellite Aryabhata was launched in 1975.

### **Chandrayaan - 1:**

Our country launched a satellite Chandrayaan-1 (meaning Moon vehicle) on 22nd October 2008 to study about the Moon. It was launched from Sathish Dhawan Space Center in Sriharikota, Andhra Pradesh with the help of PSLV (Polar Satellite Launch Vehicle) rocket. It was put into the lunar orbit on 8th November 2008.

The spacecraft was orbiting around the Moon at a height of 100 km from the lunar surface. It collected the chemical, the mineralogical and the geological information about the Moon. This mission was a major boost for the Indian space programs and helped to develop its own technology to explore the Moon. Chandrayaan-1 was operated for 312 days and achieved 95% of its objectives. The scientists lost their communication with the space craft on 28th August 2009. On the successful completion of all the major objectives, the mission was concluded.

### **Objectives of Chandrayaan-1:**



The following are the objectives of Chandrayaan – 1 mission.

- To find the possibility of water on the Moon.
- To find the elements of matter on the Moon.
- To search for the existence of Helium-3.
- To make a 3-dimensional atlas of the Moon.
- To study about the evolution of the solar system.

### **Achievements of Chandrayaan-1 :**

The following are the achievements of Chandrayaan-1 mission.

- The discovery of presence of water molecules in the lunar soil.
- Chandrayaan-1 confirmed that the Moon was completely molten once.
- Chandrayaan-1 has recorded images of the landing site of the US space-craft Apollo-15 and Apollo-11.
- It has provided high-resolution spectral data on the mineralogy of the Moon.
- The existence of aluminium, magnesium and silicon were picked up by the X-ray camera.
- More than 40,000 images have been transmitted by the Chandrayaan-1 camera in 75 days.
- The acquired images of peaks and craters show that the Moon mostly consists of craters.
- Chandrayaan-1 beamed back its first images of the Earth in its entirety.
- Chandrayaan-1 has discovered large caves on the lunar surface that can act as human shelter on the Moon.

### **Mangalyaan (Mars vehicle):**

After the successful launch of Chandrayaan-1, ISRO planned an unmanned mission to Mars (Mars Orbiter Mission) and launched a space probe (space vehicle) on 5th November 2013 to orbit Mars orbit. This probe was launched by the PSLV Rocket from Sriharikota, Andhra Pradesh.

Mars Orbiter Mission is India's first interplanetary mission. By launching Mangalyaan, ISRO became the fourth space agency to reach Mars. Mangalyaan probe traveled for about a month in Earth's orbit, and then it was moved to the orbit of Mars by a series of projections. It was successfully placed in the Mars-orbit on 24th September 2014.

Mars Orbiter Mission (MOM) successfully completed a period of 3 years in the Martian orbit and continues to work as expected. ISRO has released the scientific data received from the Mangalyaan in the past two years (up to September 2016).

### **Objectives of Mangalyaan:**

The following are the objectives of Mangalyaan mission.

- To develop the technology required for interplanetary mission.
- To explore the surface of Mars.
- To study the constituents of the atmosphere of Mars.
- To provide information about the future possibility of life and past existence of life on the planet.

### **Chandrayaan - 2**

ISRO has currently launched a follow-on mission to Chandrayaan-1 named as Chandrayaan-2, on 22nd July 2019. Chandrayaan-2 mission is highly complex mission compared to previous missions of ISRO. It brought together an Orbiter, Lander and Rover. It aims to explore South Pole of the Moon because the surface area of the South Pole remains in shadow much larger than that of North Pole.

#### **Orbiter:**

It revolves around the moon and it is capable of communicating with Indian Deep Space Network (IDSN) at Bylalu as well as Vikram Lander.

#### **Lander:**

It is named as Vikram in the memory of Dr. Vikram A. Sarabhai, the father of Indian space program.

#### **Rover**

It is a six wheeled robotic vehicle named as 'Pragyan' (Sanskrit word) that means wisdom. Chandrayaan-2 was successfully inserted into the lunar orbit on 20th August 2019. In the final stage of the mission, just 2.1 km above the lunar surface, Lander 'Vikram' lost its communication with the ground station on 7th September 2019. But the Orbiter continues its work successfully.

### **NASA (National Aeronautics and Space Administration):**



	A	B	C	D
a.	1	2	4	3
<b>b.</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>3</b>
c.	1	2	3	4
d.	4	3	2	1

4. Which of the following can be seen in between the orbits of Mars and Jupiter?  
a. Comets                      **b. Asteroids**                      c. Meteor                      d. Meteorites
5. All stars appear to us as moving from east to west where as there is one star which appear to us stationary in its position. It is known as \_\_\_\_  
**a. Pole star**                      b. Asteroid                      c. Galaxy                      d. None of the above

