Contents

Space

- Everything that exists, from the Galactic Superclusters to the tiniest subatomic particles, comprises the *Universe.*
- Among the various theories on the origin of universe including the *steady state* andthe *pulsating universe theories,* the one most widelyaccepted has been the *Big Bang theory.*
- This theory traces the originto a primordial explosion of super-compressed cosmic matter, the energy of which has sustained the continuous expansion of universe.
- However, some recent theories have questioned the very fundamentals of the Big Bang theory.
- As for *the age of Universe,* scientists agree that it is about 11 to 17 aeons or billion years.
- The Universe comprises Galaxies that are huge congregation of stars held together by the forces of gravity.
- Optical and radio telescope studies indicate the existence of about 100 billion galaxies in the visible universe.
- Galaxies occur in three structural forms: Spiral, Elliptical and Irregular.
- *Spiral* galaxies have a central nucleus with great spiraling arms trailing around them, examples include our Milky Way and the Andromeda galaxies.
- *Elliptical* galaxies are without spiraling arms.
- *Irregular* ones have no clear shape.
- Stars account for most of the galactic mass.
- They tend to form groups called *constellations.* Lone stars are a rarity. Stars that appear single are often double stars or *binaries* revolving around a common centre of gravity.
- Stars go through a definite evolutionary sequence. After a star is born, it enters the *main sequence* stage. This stage is marked by a helium core becoming increasingly heavy, accompanied with expanding outer layers.
- At this stage, it is considered an *Adult Star.*
- The process continues until it becomes a massive Red Giant.
- If the mass is relatively small, like that of our sun, the gases that reach the outer layer are expelled. As these expelled gases cool and contract, the star becomes a *White Dwarf*
- If the star is larger, the final stages of its giant star phase end either in a supernova explosion which sometimes leaves behind *neutron star.,* called pulsars or collapse and compact to form *black holes.*

Black Holes

- *Black Holes* result from the collapse and compaction under gravity, of a star of mass greater than three times that of the sun, at the end of its life-cycle. Its density becomes so great that nothing, not even light, can escape from its gravity.
- It is so-called because it cannot be viewed directly.
- S Chandrashekhar, the renowned Indian Physicist had predicted an upper limit to the mass of stars, above which they either explode or form a black hole.
- This is referred to as the *Chandrashekhar Limit.*

Unit of Measurement

1. *Light year:* A light-year is a unit of distance. It is the distance that light can travel in one year. Light moves at a velocity of about 300,000 kilometers (km) each second. So in one year, it can travel about 10 trillion km. More precisely, one light-year is equal to 9,500,000,000,000 kilometers. Solar system is less than one light day across.
2. *Astronomical Unit (A.U.):* The Astronomical Unit is the average distance between the Sun and Earth. Its value is 149,597,870 km (about 93 million miles). There are a variety of ways to measure it, but the most accurate is to fly spacecraft to various planets. It is used to measure distances within the solar system. The distance between sun and Pluto averages 39AU. In terms of space dimensions, a light year is made up of about *60,000* Aus.
3. *Parsec:* The parsec (symbol pc) is a unit of length used in astronomy. The length of the parsec is based on the method of trigonometric parallax, one of the oldest methods for measuring the distances to stars. The name *parsec* stands for "parallax of one second of arc", and one parsec is defined to be the distance from the Earth to a star that has a parallax of 1 arc second. The actual length of a parsec is approximately 3.086x1016 m, or about 3.262 light-years.

THE SOLAR SYSTEM

- The Sun, the eight planets along with their respective *satellites*, the *asteroids*, the *meteoroids*, the *comets*, the interplanetary dust and the electrically charged gases called plasma, together make up the solar system.
- The solar system consists of the sun and its nine planets.
- The planets revolve around the sun in elliptical orbits.
- The planets do not produce light of their own.
- Almost all the energy of the solar system is derived from the sun.
- The surface of the sun is covered with burning gases at a temperature of about 6000° C.
- Mercury, the smallest planet, is nearest to the sun.
- Pluto is smaller than the earth and is the furthest away from the sun.
- Each planet takes a different amount of time to complete one orbit around the sun.
- This is because their distances from the sun vary.
- Mercury completes its orbit in 88 days, which means that one year on Mercury last for 88 days.
- The earth completes its orbit in 3651/4 days - the length of one year on earth.
- The moon takes about 27 days to revolve about the earth.

THE GENESIS

- The Sun together with the planet were formed essentially at the same time and from the same primordial material.
- This is evident from the orderly revolution of all nine planets along the Sun's equatorial plane.
- The most acceptable theory of planetary evolution is the *nebular hypothesis.*
- Any theory for the origin of the solar system must explain the main observable features of the solar system:
- All planets revolve around Sun counterclockwise
- All planets except Venus rotate on axis counterclockwise
- All planets orbits lie in plane of ecliptic
- Axes of planets except Uranus & Pluto perpendicular to ecliptic
- Compositional variation (inner planets - Terrestrial; Outer planets - Gaseous)

SOLAR NEBULA THEORY

- The solar system formed 4.6 Ga when interstellar material in a spiral arm of Milky Way Galaxy condensed and collapsed. Under influence of gravity this material flattened into a counterclockwise rotating disk
- 90% mass is concentrated in the center with rest occurring in solar nebula.

- Compression at center raised T > 106 K- Sun formed when H/He burning initiated.

BIG BANG THEORY

The Big Bang Theory postulated in 1950's and 1960's and validated in 1972 (May) through convincing evidences received from COBE (Cosmic Background Explorer) explains the origin of universe and everything in it including ourselves on the premise that the universe contained many million of gallaxies, each one 'having thousands of millions of stars and each star having numerous planets around them'. According to this theory everything in the universe emerged from a point known as singularity, 15 billion years ago.

The galaxies moved apart from one another as the empty space between them expanded. In the beginning the universe was much smaller as there was less space between the galaxies. All of the matter in the universe was greated in one instant at a fixed moment in time. "As the universe expanded for 15 billion years, the hot radiation in the original fireball also expanded with it, and cooled as a result." It may be summerized that there was a single fireball some 15 billion years ago. 'There were already wispy clouds of matter stretching across vast distances, upwards 500 million light years across. As those coulds collaposed in upon themselves, pulled together by their own gravity, they would have broken up and formed clusters of galaxies with the galaxies themselves breaking up into stars like those of the Milky Way' (John Gribbin). The stars might have broken up to form their planets as our earth.

THE SUN

- The Sun accounts for 99.85% of mass of the solar system.
- The immense gravitational pull of the Sun keeps the planets rotating around it in definite orbits.
- It continuously gives off energy in the form of visible light, infra red, ultra violet, X-rays, gamma rays, radio waves and plasma.
- The period of revolution of the Sun around the galactic centre is 250 million years. This period is called a *Cosmic* or *Galactic Year.*
- Like all other stars, the Sun is mainly composed of hydrogen and helium. Nuclear fusion in the core of the Sun is source of all its energy.
- The glowing surface of the Sun, that we see, is called the *Photosphere.* Above the photosphere is the red coloured *Chromosphere* and beyond it is the magnificent *Corona*, which is visible during eclipses.
- The Sun is continuously emitting streams of protons in all directions either as persistent spiral streams called *Solar Winds* or as bouts of incandescent material called *Solar Flares.*
- The constituent particles of solar wind are trapped by the earth's magnetic field and enter the earth's upper atmosphere as auroral displays described as *Aurora borealis* in the northern hemisphere and *Aurora australis* in the southern hemisphere.
- Solar flares being hot ionised gases pose danger to satellite communication.
- The surface of the sun changes continuously. Bright spots called *Plages* and dark spots called *Sunspots* frequently form and disappear.
- Sunspots are cold and dark regions on the surface of the sun with a periodicity of 11 years. These spots greatly influence the global climate.

PLANET

A planet is a celestial body orbiting a star or stellar remnant that is massive enough to be rounded by its own gravity, is not massive enough to cause thermonuclear fusion, and has cleared its neighbouring region ofplanetesimals. The term *planet* is ancient, with ties to history, science, mythology, and religion.

The planets were originally seen by many early cultures as divine, or as emissaries of the gods. As scientific knowledge advanced, human perception of the planets changed, incorporating a number of disparate objects. In 2006, the International Astronomical Union officially adopted a resolution defining planets within the Solar System. This definition has been both praised and criticized, and remains disputed by some scientists

since it excludes many objects of planetary mass based on where or what they orbit.

The planets were thought by Ptolemy to orbit the Earth in deferent and epicycle motions. Though the idea that the planets orbited the Sun had been suggested many times, it was not until the 17th century that this view was supported by evidence from the first telescopic astronomical observations, performed by Galileo Galilei. By careful analysis of the observation data, Johannes Kepler found the planets' orbits to be not circular, but elliptical. As observational tools improved, astronomers saw that, like Earth, the planets rotated around tilted axes, and some shared such features as ice caps and seasons. Since the dawn of the Space Age, close observation by probes has found that Earth and the other planets share characteristics such as volcanism, hurricanes, tectonics, and even hydrology.

Planets are generally divided into two main types: large, low-density gas giants, and smaller, rocky terrestrials. Under IAU definitions, there are eight planets in the Solar System. In order of increasing distance from the Sun, they are the four terrestrials, Mercury, Venus, Earth, and Mars, then the four gas giants, Jupiter, Saturn, Uranus, and Neptune. Six of the planets are orbited by one or more natural satellites. Additionally, the Solar System also contains at least five dwarf planets and hundreds of thousands of small Solar System bodies.

Since 1992, hundreds of planets around other stars ("extrasolar planets" or "exoplanets") in the Milky Way Galaxy have been discovered. As of February 14, 2012, 760 known extrasolar planets (in 609 planetary systems and 100 multiple planetary systems) are listed in the Extrasolar Planets Encyclopaedia, ranging in size from that of terrestrial planets similar to Earth to that of gas giants larger than Jupiter. On December 20, 2011, the Kepler Space Telescope team reported the discovery of the first Earth-sized extrasolar planets, Kepler-20e and Kepler-20f, orbiting a Sun-like star, Kepler-20. A 2012 study, analyzing gravitational microlensing data, estimates an average of at least 1.6 bound planets for every star in the Milky Way.

Multiple Choice Questions

1. Which one of the following is the appropriate reason for considering the Gondwana rocks as most important of rock systems of India'?
   a) More than 90% of limestone reserves of India are found in them
   b) More than 90% of India's coal reserves are found in them
   c) More than 90% of fertile black cotton soils are spread over them
   d) None of the reasons given above is appropriate in this context
2. Which one of the following pairs is not correctly matched?

	Dam/Lake	**River**
a)	Govind Sagar	Satluj
b)	KolleruLake	Krishna
c)	UkaiReservoir	Tapi
d)	Wular Lake	Jhelum

3. What are the possible limitations of India in mitigating the global warming at present and in the immediate future?
   1. Appropriate alternate technologies are not sufficiently available
   2. India cannot invest huge funds in research and development
   3. Many developed countries have already set up their polluting industries in India

   Which of the statements given above is/ are correct?
   a) 1 and 2 only b) 2 only
   c) 1 and 3 only d) 1, 2 and 3
4. At which one of the following places do two important rivers of India originate; while one of them flows towards north and merges with another important rivers flowing towards Bay of Bengal, the other one flows towards Arabian Sea?
   a) Amarkantak b) Badrinath
   c) Mahabaleshwar d) Nasik
   d) Shevoroy Hills
5. Consider the following pairs:

	Tributary River	**Main River**
1.	Chambal:	Narmada
2.	Sone :	Yamuna
3.	Manas :	Brahmaputra

   Which of the pairs given above is/are correctly'matched?
   a) 1, 2 and 3 b) 1 and 2 only
   c) 2 and 3 only d) 3 only