Government of Tamilnadu

Department of Employment and Training

Course : TNPSC Group II Exam

Subject : Physics

Topic : **The Universe**

Commissioner,
Department of Employment and Training.

THE UNIVERSE

The universe is commonly defined as the totality of everything that exists including all physical matter and energy, the planets, stars, galaxies and the contents of intergalactic space

Big

- Theories of the universe form a discipline known as cosmology.
- Einstein was the first truly modern cosmologist.
- An evolving universe was first discussed in the 1920s by **Aleksandr Fried Mann, Georges Lemaitre** and others.

Pulsating Theory

- The total mass of the universe is more them a certain value the expansion stopped by the gravitational pull. Then the universe may again contract.
- At Present the Universe is expanding

Steady State Theory

- The Steady State theory (also known as the infinite Universe theory of continuous creation) is a model developed in 1948 **by Fred Hoyle, Thomas Gold and Hermann Bondy** and others as an alternative to the Big Bang theory.
- In steady state views, new matter is continuously created as the universe was expands.

Measuring Distances In Astronomy

- Light year is the distance that light travels in a year. Since light travels at 3 Lakhs kilometres a second,
- It goes about 9.467×10^{15} m in a year.

Astronomical Objects: In 1924, Edwin Hubble first demonstrated existence of galaxies beyond Milk Way.

Galaxies

- Galaxies are giant assemblies of stars, gases, and dust into which most of the visible matter in the universe is concentrated.
- The majority of the galaxies close enough to be observed in any detail can be divided into three broad categories elliptical, spiral and irregular.
- The nearest outside galaxies to our own (the Milky Way) are the large and small clouds of Magellan (about 100,000 light years distant from us). Another well-known galaxy is Andromeda, the largest of the nearby galaxies.

The Milky Way

- It is the giant star system to which the sun belongs. The Galaxy has a spiral structure and, like other spiral galaxies, is highly flattened.
- The diameter of the galactic disc is 100,000 light years and the sun is situated at a distance of 27,000 light years from the centre.

The Galactic Year :

The galactic year also known as a cosmic year is the duration of time required for the solar system to orbit once around the centre of the milky way galaxy. Estimates of the length of orbit range from 225 to 250 million terrestrial years.

Nebula

- A nebula is a cloud of interstellar gas and dust that can be observed either as a luminous patch of light "a bright nebula" or as "a dark hole or band against a brighter background" a dark nebula.

Stars

- A star is a celestial body, consisting of a large, self-luminous mass of hot gases held together by its own gravity.
- The composition by weight of an average star is about 70% hydrogen, 28% helium, 1.5% carbon, nitrogen, neon 0.5 iron group and heavier elements.
- The star contains by far the largest fraction of the mass of the

Sun spots are the magnetic storms on the surface of the sun.

universe. Stars are born, produce nuclear energy, evolve, and eventually die.

- The smallest stars are only about one-tenth the size of the sun.
- The largest are several hundred times larger. They look small only because they are far away.

Clusters

- Groups of star held by mutual gravitational force in the galaxy are called star clusters.
- A group of 100 to 1000 stars is called galactic cluster.
- A group of about 10,000 stars is called globular cluster.

1. Dwarf:

- If the original mass of the star is less than about 2 solar masses we get a dense white dwarf or less than 1.2 solar mass.
- As there is no nuclear fuel left in the white drawf it just cools off slowly changing its colour from white to yellow, to red and finally becomes a dark body.

2. Neutron Star:

- If the original mass of the star was between 2 and 5 solar masses, the back kick of the supernova explosion will compress the core of the star to nuclear densities giving rise to a neutron star.
- The mass of a neutron star is less than 2 solar masses and its radius is about 10 kilometres. Neutron stars have large magnetic fields. If the magnetic axis is inclined to the axis of rotation, the star emits pulses at regular intervals, the periods of which range from 30 milli seconds to 3 seconds. These are pulsars the first of which was discovered by the radio astronomers in 1967.

3. Black Hole:

- If the original mass of the star was more than 5 solar masses, the back kick of the supernova explosion is so violent that the core continues to contract indefinitely, giving rise to a black hole.
- As the contraction proceeds, the radius decreases continuously and acceleration due to gravity g, at the surface goes on increasing.

- Finally a stage comes when the g value is so large that even the photon cannot escape from the surface of the body.

Constellation:

- On a clear night, here and there groups of stars seem to form special shapes. Such a group or shape is called a constellation.

The Solar System

- The solar system is a group of celestial bodies comprising the sun and the large number of bodies that are bound gravitationally to the sun and revolve around it.
- The latter include the planets, asteroids, comets etc.
- Various theories were given to explain the origin of the solar system

No	Hypothesis	Pro pounder
1.	Gaseous hypothesis	Kant
2.	Nebular hypothesis	Laplace
3.	Planetesimal hypothesis	Chamber line and Moultan
4.	Tidal hypothesis	Sir James jeans and Harold Jeffreys
5.	Binary star Hypothesis	HN Russell
6.	Supernova Hypothesis	F Hoyte
7.	Inter stellar dust hypothesis	Otto schmidt
8.	Electromagnetic hypothesis	HAIFVEN
9.	Protoplanet hypothesis	G kuiper
10.	Nebular cloud hypothesis	Dr.Von Weisacker

Sun

- The sun is the star at the centre of the solar system.
- It is the nearest star to the earth. As a star it is a rather ordinary one, of average size. Many other stars are bigger, heavier, hotter and brighter.
- The next nearest star, Alpha Centauri,

SUN

Diameter	:	1,392,000km
Volume	:	1,304,000 times, Earth's;
Gravitational Pull	:	28 x Earth's
Relative Density	:	1.4 kg/m^3
Temperature	:	6000°C at surface and 15,000,000°C at the centre

- The sun atmosphere
  1. Photosphere - 14 x 10^6k
  2. Chromosphere - 6000k

- Sun Produces energy by fusion
  Two sets of Fusion reactions (hydrogen into helium)
  1. Proton Proton Chain
  2. CN cycles (minor amount to the energy) Four hydrogen nuclei combine to a helium nucleus. This mass difference converted to energy.
     ($E = mc^2$) This energy which keeps the sun shining.

PLANETS

- A planet is a heavenly body that orbits the sun or another star and shines only by the light it reflects.

The Terrestrial Planets:

- Next to the Sun, the most important members of the solar system are the planets.
- Of the nine planets, the nearest four to the Sun namely Mercury, Venus, Earth and Mars are called the terrestrial planets because their structure is similar to the earth.
- The common features of these planets are:
  1. a thin rocky crust,
  2. a mantle rich in iron and magnesium and
  3. a core of molten metal's.
- The terrestrial planets have very few moons. These planets have thin atmospheres.

The Jovian Planets:

- The planets outside the orbit of Mars are much farther off than the terrestrial planets.
- The planets outside the orbit of Mars are called Jovian planets because their structure is similar to that of Jupiter.

- These are all gaseous bodies. They have ring systems around them and have large number of moons.

MERCURY

- Mercury is the inner most and smallest planet in the solar system orbiting the sun once every 87.969 Earth days.
- It is nearly of the same size as the moon and is much smaller compared to the earth with an equatorial radius of 2,439.7 km.
- The Mercury usually becomes visible in September and October just before sunrise in the eastern sky as a morning star.
- Mercury too has no atmosphere and its surface is rocky and mountainous too.

VENUS

- Venus or Shukra is the second planet in terms of its distance from the sun orbiting it every 224.7 Earth days.
- It is a planet, which our elders often called an evening or a morning star.

Important Facts

Biggest planet	Jupiter
Biggest satellite	Gannymede
Blue Planet	Earth
Green planet	Uranus
Brightest planet	Venus
Brightest star	Sirius (Dog star)
Closest star of solar system	Alpha centauri
Coldest planet	Neptune
Evening star	Venus
Farthest planet from sun	Neptune
Planet with maximum number of satellites	Jupiter
Fastest revolution in solar system	Mercury
Hottest planet	Venus

- The mass of the atmosphere of Venus is 96.5% co_2, with of the remaining 3.5% being nitrogen. Venus has no moon or satellite of its own.

THE EARTH

- Earth is the third planet in term of distance from the sun.

MARS

- The next planet in terms of distance from the sun is the Mars or Mongol. It appears reddish and therefore it is also called the red planet.

Important Facts

Importance	Planet
Den sect planet	Earth
Fastest rotation in solar system	Jupiter
Moring star	Venus
Nearest planet to earth	Venus
Nearest planet to sun	Mercury
Red planet	Mars
Slowest revolution in solar system	Neptune
Slowest rotation in solar system	Venus
Smallest planet	Mercury
Smallest satellite	Deimos
Earth's twin	Venus
Only satellite with an atmosphere like earth	Titan

JUPITER

- Jupiter is the largest of all the planets.
- Its mass is more than the combined mass of all other planets.

SATURN (SHANI)

- Saturn is the most distant planet known to the early astronomers. Its distance from the sun is almost two times that of Jupiter.
- Saturn is its beautiful rings that encircle the planet.
- There are three distinct rings that surround the planet.
- These rings are not visible with the naked eyes and can be observed only with the help of a telescope.

URANUS

- Uranus was the first planet to be discovered with the help of a telescope.
- William Herchel discovered the planet in 1781.
- Hydrogen and methane have been detected in the atmosphere of Uranus.

NEPTUNE

- Neptune is the eighth planet in terms of its distance from the

sun. This is the second planet that was discovered with the help of telescope.

Albedo :

- The ratio of the amount of solar energy reflected by planet to that incident in it is known as albedo.
- The Albedo of Earth - 0.37.
- The Albedo of Venus is 85. Its reflects 85% light. So its contain high density atmosphere.
- Mercury albedo is 6%. So it not contain atmosphere.

- There are two factors which determine whether the planets have atmosphere or not,
  i. acceleration due to gravity on it surface
  ii. the surface temperature of the planet.
- The value of g for moon is very small (1/6th of the earth).
- Mercury has larger value of g than moon. There is no atmosphere because its very close to the sun and it temperature is high.

Escape speed of earth is 11.2 km/s

The escape speed is ve $= \sqrt{2gR}$

Mercury = 4 km/s

Jupiter = 60 km/s

moon = 2.5 km/s

Sun =620 km/s

(Escape speed very high)

Kepler's laws

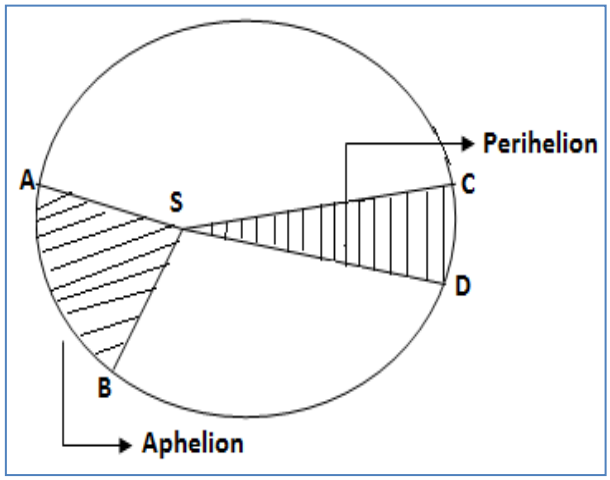
Motion of the planets around the sun Johannes Kepler (1571 – 1630) obtained the following three laws known as Kepler's Laws).

Law - I : the planets revolve around the sun in the elliptical orbits with sun at one of the focus.

Law - II : The radius vector sweeps out equal area in equal interval of time. This law may be derived from law of conservation of angular momentum.

The Kinetic energy of the planet is maximum when it is closest to the sun.

Law - III: The square of the period of revolution of a planet around the sun is directly proportional to the cube of the



mean distance between the planet and the sun.

$$T^2 \propto r^3$$

T – Planet revolution time

R – Mean distance between the planet and sun.

Asteroids

- Asteroids or minor planets circle in a broad belt between the orbits of Mars and Jupiter.
- They are chunks of rock covered in frozen gases. The largest is ceres.
- Today more than one thousand of these small bodies have been discovered and it is estimated that there are more than 50,000 in all. The orbits of some extend beyond the Mars-Jupiter space.

Comets

- A comet is a member of the solar system that travels around the sun in an orbit that generally is much more eccentric than the orbits of planets.
- Typical comets have three parts: the nucleus, coma, and comet tail.
- A comet cannot move in a circle.
- Thus, all periodic comets must move in ellipses.
- The comets approaches the sun, it is heated by the sun radiant energy vapourises and forms a leaf of about 10,000 km in diameter. The comets also develops a tail pointing away from the sun. Halley's comets is a Periodic comet which made its appearance in 1910 and in 1986. It would appear again in 2062 years.

Meteors and Meteorites

- The comets break into pieces as they approach very close to the sun. When the earths orbits cross the orbit of comet these broken pieces fall on the earth, Most of the pieces are burnt. They are called shooting stars. (Meteors)
- Some bigger size fully not burnt this called Meteorites.