STUDY OF THE UNIVERSE (OTHER THAN OUR SOLAR SYSTEM)

WHAT IS THE UNIVERSE?
- The ancient Greek astronomers thought that the universe was made up of a few thousand stars, the sun and the moon. These all revolved around the Earth, which was the centre of the universe.
- Today we know that the Earth and moon revolve around the sun, and that the sun is a relatively small star, one of the billions of star in the space, the universe.
- If you look at the night sky on a moonless night, you will notice that most of the stars lie in a “milky” band. We call this the Milky Way Galaxy.
- Our sun and an estimated 100 billions (100 thousand millions) other stars belong to the Milky Way Galaxy.
- Our solar system consists of 9 planets and their moons which altogether only occupies a very small space in the universe.
- Up until the turn of this century (20th), the Milky Way was thought to be the whole universe. However, with the aid of powerful telescopes, the American astronomer, Edwin Hubble showed in 1923 that the well-known Andromeda Spiral was actually another galaxy outside the Milky Way.
- Hubble’s discovery encouraged other astronomers to search for galaxies. Over 1000 million (1 billion) galaxies have since been identified.
- Galaxies can be classified into 3 main types:-
  ◦ Spiral galaxy - rotates on an imaginary axis that passes through the centre of the spiral. More than 50% of galaxies are of this type.
  eg. The Milky Way Galaxy - contains about 100 billions stars, gas and cosmic dust. It is rotating slowly at one revolution per 200 million years. The Andromeda galaxy - about twice as large.
  ◦ Elliptical galaxy - egg-shaped and has a bright central region containing a crowded mass of stars.
  ◦ Irregular galaxy - has no shape or order. It is the least common type, accounting for only 3 percent of all galaxies.
  eg. the Magellanic Clouds (2 separated galaxies very close to our local galaxy) - the Large and Small Magellanic Clouds - look very much like clouds of stars without any particular shape.

[Q.1] How would you describe our Sun?

[Q.2] What is the difference between spiral and elliptical galaxies?

[Q.3] What is the contribution of Edwin Hubble in the study of the universe?

[Q.4] What many stars are there in the Milky Way Galaxy?
helium atoms and an enormous amount of energy is released at a rapid rate equivalent to
about a million million hydrogen bombs being exploded every second.
- The temperature of the core is extremely high at about 14 millions degree Celsius.
- Energy from the core is radiated to gases in the mantle (middle region). Hot gases transfer
  energy to the sun’s surface by convection, producing granules on the surface which looks like
  the bubbling of boiling water.
- From time to time, there are huge eruptions of glowing gas shooting out into space. The
  surface temperature is round about 6000 degree Celsius.
- The colour of a star indicates its surface temperature (how hot a star is?)
  The sun is describe as a yellow-white star, having a mild temperate; compared to blue stars
  which are very hot, while red stars are cooler one.

<table>
<thead>
<tr>
<th>Colour</th>
<th>surface temp</th>
<th>example</th>
<th>temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>blue</td>
<td>above 8000 K</td>
<td>Rigel</td>
<td>12300</td>
</tr>
<tr>
<td>blue-white</td>
<td>6500-8000</td>
<td>Canopus</td>
<td>7000</td>
</tr>
<tr>
<td>white-yellow</td>
<td>5000-6000</td>
<td>Sun</td>
<td>5600</td>
</tr>
<tr>
<td>orange</td>
<td>3500-5000</td>
<td>Arcturus</td>
<td>4300</td>
</tr>
<tr>
<td>red</td>
<td>below 3500 K</td>
<td>Betelgeuse</td>
<td>3000</td>
</tr>
</tbody>
</table>

Temperatures are measured in Kelvin in astronomy.
Zero K = -273°C (the coldest temp)
20°C = 293K

- The energy that is produced in the sun and other stars is radiated out into space and onto the
  Earth. This energy is called electromagnetic radiation. It includes many forms such as
  ultraviolet, visible, infrared, radio, microwave, X-rays and cosmic radiation.

- [Q.9] What is the chemical composition of our Sun?

- [Q.10] What is the range of temperature of the Sun (consider the core’s temp as well)?


- [Q.12] Describe the process of nuclear fission inside the Sun. What is the use of such a reaction?

**STAR PATTERNS (CONSTELLATIONS)**

- People have been observing the stars for thousands of years. They noticed unchanging
  patterns of stars in the sky and gave these star patterns (constellations) fanciful names like the
  followings:
  - Orion          the hunter
  - Taurus         the bull
  - Scorpio        the scorpion
  - Leo            the lion
  - Crux           the Southern Cross
  - Centaurus      the half human and half horse
  - Telescopium     the telescope
- A constellation is a group of stars which form a pattern in the sky.
- The ancient Greek astronomers found and named 48 constellations. In those times the
  southern skies were unknown to the Greeks. Today, there are more than 100 constellations
  listed.
• This model suggests that the universe is expanding and will continue to expand into limitless space.

• The Steady State Theory (Model):
  • This model proposes that the universe did not have a beginning but has always existed.
  • New matter is constantly being made everywhere in the universe, so new stars and galaxies are formed in the space and slowly move apart in the expanding universe.
  • This model also suggests that we see the universe now as it was in the past or will be in the future.

[Q.16] What do you think is the origin of the universe?

[Q.17] What causes the planets, moons, stars to be in places in the universe?

[Q.18] Give some differences between the Big Bang and Steady State theories.

THE FUTURE OF THE UNIVERSE

• Again, there are two major theories put forward by astronomers in predicting the future of the universe.

• The “Continually Expanding” theory suggests that the universe will continue to expand, but at a decreasing rate. This theory assumes that the universe is not dense enough to be pulled back by gravity towards the centre. At present, most astronomers accept this theory.

• The “Pulsating Universe” theory suggests that the universe will eventually stop expanding and that gravity will pull it back towards the centre. There will be a “big crunch” followed by another “big bang”. According to this theory, the universe will continue to expand and contract for ever.

[Q.19] What do you think will be the future of the Earth, Solar System, Milky Way Galaxies and the universe as a whole? (No definite answer, your opinion only).

THE DEATH OF A STAR

• As hydrogen is used up, the helium formed accumulates at the centre of the star.

• Another nuclear reaction takes place, forming the heavier element carbon. The star begins to contract. What happens next depends on the mass of the star.

• If the star has a mass more than about 4 times that of our sun:
  • Iron begins to form as a result of yet another nuclear reaction.
  • The star contracts violently as there is much more gravitational pull than the outward force due to the release of energy.
  • This results in a gigantic explosion called supernova.
  • The remaining heavy core of the star is left over, packed tightly into a sphere less than 30 km across!
  • The core will contract even further, forming a neutron star.
  • Rotating neutron stars are called pulsars because of the rapidly pulsating radio signals they emit.

• If the original star has more than about 10 times the mass of the sun:
  • A supernova occurs as above.
  • The core of this extremely large star collapses to a greater extent into a black hole.

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