ASTROPHYSICS QUESTIONS

2 MARKS

1. What are the two main elements in all stars?

All stars are made primarily of hydrogen and helium at birth.

2. What are the important physical properties of stars?

1. Luminosity
2. Brightness
3. Surface temperature
4. Spectral type
5. Mass

3. What two basic physical properties do astronomers use to classify stars?

Stars are classified by their luminosity and surface temperature, which depend primarily on a star's mass and its stage of life.

4. What is luminosity, and how do we determine it?

A star's luminosity is the total power (energy per unit time) that it radiates into space. It can be calculated from a star's measured apparent brightness and distance, using the luminosity–distance formula:

$$\text{Apparent brightness} = \frac{luminosity}{4\pi \times (distance\ ^2)}$$

5. What is apparent and absolute brightness?

Two types of Brightness: 1) Apparent Brightness

2) Absolute Brightness

Apparent Brightness is the measure of visible brightness from earth which depends on the distance of the star.

Absolute Brightness is the measure of visible brightness at a distance of 10 parsec.

6. **How are stars classified into spectral types?**

   From hottest to coolest, the major spectral types are O, B, A, F, G, K, and M. These types are further subdivided into numbered categories. For example, the hottest A stars are type A0 and the coolest A stars are type A9, which is slightly hotter than F0.

7. **What determines a star's spectral type?**

   The main factor in determining a star's spectral type is its surface temperature. Spectral type does not depend much on composition, because the compositions of stars—primarily hydrogen and helium—are nearly the same.

8. **What is the most important property of a star?**

   A star's most important property is its mass, which determines its luminosity and spectral type at each stage of its life.

9. **What is colour index?**

   Instead of colour we can use colour index (number) to describe a star. Colour index is defined by taking the difference in magnitude at 2 different wavelengths. Using UV, Blue and Visible colour filter, there are 3 possible differences.
   B-V colour index (Blue & Visible)
   U-B colour index (UV & Blue)
   U-V colour index (UV & Visible)

10. **Why do massive stars have shorter lifespan?**

    Larger stars have shorter live. Larger stars have more fuel, but they have to burn (fuse) it faster in order to maintain equilibrium. Because fusion occurs at a faster rate in massive stars, large stars use all their fuel in a shorter length of time. But a smaller star has less fuel, but its rate of fusion is not as fast. Therefore, smaller stars live longer than larger stars because their rate of fuel consumption is not as rapid.

11. **What are the end products of a star?**

    If a star exhausted all it fuels, it ends up with one of the following Stage.

    White dwarf (or) Neutron star (or) Black hole.

Let Ms-Mass of our sun

if mass of the star is < 1.4 Ms It becomes a **white dwarf**

if mass of the star is in between 1.4-3 Ms It becomes a **Neutron star**

if it is greater than 3Ms It becomes a **Black hole**

where 1.4 Ms is Chandrasekhar limit. Below which the star is white dwarf above which star is neutron star.

12. What is Chandrasekhar limit?

A stellar mass equal to about 1.4 solar masses is called Chandrasekhar limit. If the mass of the star is below Chandrasekhar's limit it becomes a white dwarf and above which they become a neutron stars or black holes.

13. What is white dwarf?

Small stars of masses up to 1.4 Ms (***Chandrasekhar limit***) becomes a white dwarf after its death. After exhausting all its fuel, a star contracts gravitationally and becomes a white dwarf. White dwarfs are **degenerated stars** which are very dense and composed mostly of **electron-degenerate matter**. They have masses comparable to that of the Sun, volumes comparable to that of Earth. Typical composition: Carbon and/or Oxygen Example: companion of star Sirius is white dwarf.

14. What is a neutron star?

If mass of the star is in between 1.4 -3 Ms it becomes a Neutron star after its death. Neutron stars are the equivalent of white dwarfs, but the degeneracy pressure is provided by neutrons, not electrons. There is no energy to counteract the contraction. As the consequence, the density of the star increases, the electrons are squeezed into the nucleus. The following reaction takes place.

$$p + e^{-} \rightarrow \mathrm{n} + \nu$$

The neutrino escapes, as neutron only remains. Example: In crab nebula, a neutron star is found. It is a pulsar, radiating ratio waves.

15. What is a pulsar?

A pulsar is a magnetised spinning neutron star that emits a beam of radiation mostly radio waves and also X rays and visible radiations. The beams sweep around the sky, and if the Earth happens to be in the path of the beam a pulsar is seen. The best-known pulsar is located in the Crab nebula.

16. What is a black hole?

If a neutron star undergoes gravitational collapse, the gravitational collapse of the star is total. The result is an extraordinary phenomenon ***a black hole.*** The gravitational force is strong enough so that nothing can escape from it. Even light cannot escape from it.

17. What is the structure of Milky Way?

Milky Way has the barred spiral structure. The spiral has four arms. The structure can be viewed as consisting of six separate parts: 1) a nucleus 2) a central bulge 3) a disk both thin and thick 4) a spiral arms 5) a spherical component and 6) a massive halo.

18. State Hubble's law

The expansion of the universe (or recessional velocities of galaxies) is proportional to their distance i.e the farthest they are, the fastest they move away from us.

$$\mathbf{V \propto D}$$

$$\mathbf{V = H_o D}$$

$\mathbf{H_o}$**- Hubble's** constant (km/sec/Mpc)

V – Observed velocities of the galaxy

D – Distance of the galaxy (Mpc) $\mathbf{H_o \simeq 70}$ **km/sec/Mpc**

19. What is the importance of Hubble's constant?

The Hubble's constant is one of the most important numbers in cosmology. It is useful to estimate the size and age of the universe. It indicates the rate at which the universe is expanding. The reciprocal of Hubble's constant gives an approximate age of the universe.

20. What is CMB?

Cosmic Microwave Background radiation is a radiation in the microwave part of the electromagnetic wave, which comes from all directions in outer space. It is believed that these radiations are the residual effect of the Big Bang 13.8 billion years ago. It is the oldest electromagnetic radiation in the universe. CMB is an important evidence of the Big Bang orgin of the universe.

21. What are the three major classes of binary star systems?

Three types of binary stars: 1. Visual binary stars

2. Eclipsing binary stars

3. Spectroscopic binary stars

22. How do we measure stellar masses?

We can directly measure stellar mass only in binary systems for which we are able to determine the period and separation of the two orbiting stars.We can then calculate the system's mass using Newton's version of Kepler's third law.

23. What is the Hertzsprung–Russell (H–R) diagram?

The H–R diagram is the most important classification tool in stellar astronomy. Stars are located on the H–R diagram by their surface temperature (or spectral type) along the horizontal axis and their luminosity along the vertical axis. Surface temperature decreases from left to right on the H–R diagram.

24. What are the major features of the H–R diagram?

Most stars occupy the main sequence, which extends diagonally from lower right to upper left. The giants and supergiants inhabit the upper-right region of the diagram, above the main sequence. The white dwarfs are found near the lower left, below the main sequence.

25. How do stars differ along the main sequence?

All main-sequence stars are fusing hydrogen to helium in their cores. Stars near the lower right of the main sequence are lower in mass and have longer lifetimes than stars further up the main sequence. Lower-mass main-sequence stars are much more common than higher-mass stars.

26. What determines the length of time a star spends on the main sequence?

A star's mass determines how much hydrogen fuel it has and how fast it fuses that hydrogen into helium. The most massive stars have the shortest lifetimes because they fuse their hydrogen at a much faster rate than do lower-mass stars.

27. What is a main sequence star?

Main sequence star is a star in which fusion of hydrogen into helium is taking place. It has a stable balance between the outward pressure of nuclear fusion and inward pull of gravitation.

ESSAY TYPE QUESTIONS

1. How do you measure the stellar masses?
2. What kind of information about the stars can we get from the spectral type ?
3. Explain the stages involved in the stellar evolution.
4. What are the end products of stellar evolution?
5. Explain HR diagram.
6. Explain the structure of Milky Way.
7. Explain the expansion of universe.
8. Discuss the future prospects of the universe.