Registration Number:

Date & Session:

ST.JOSEPH'S COLLEGE (AUTONOMOUS), BENGALURU -27
B.Sc. (PHYSICS) – VI SEMESTER

SEMESTER EXAMINATION: APRIL 2023

(Examination Conducted in May 2023)

PH 6218-Astronomy, Astrophysics and Nuclear Physics

Time: $2\frac{1}{2}$ **hours** **Maximum marks: 70**

This question paper has 2 printed pages and 3 parts

PART A

Answer any **FOUR** of the following questions. Each question carries 10 marks. [$4 \times 10 = 40$]

1. (a) Why do we need space based observatories for astronomical observations in γ-rays and X-rays? Mention any three such satellites and the wavelengths in which they carry out astronomical observations. [5]
   (b) Write a brief note on the magnitude scales of stars. [5]
2. (a) What are the advantages a reflecting telescope have over a refracting telescope? [5]
   (b) What are the major constituents of a galaxy? Write a note on the classification of galaxies . [5]
3. (a) With the help of a neat diagram, explain Hertzsprung-Russel (HR) diagram. [5]
   (b) Using the HR diagram, explain the evolution of stars. [5]
4. (a) State the assumptions and obtain an expression for the hydrostatic equilibrium of a star. [5]
   (b) Using virial theorem, derive an expression for the average temperature of a sun like star. [5]
5. Give the theory of successive disintegration of a radioactive substance. Hence obtain the condition for secular equilibrium. [10]
6. Describe the construction and working of a cyclotron with theory. [10]

PART B

Solve any **FOUR** of the following problems. Each problem carries 5 marks. [$4 \times 5 = 20$]

Given:-G $= 6.6 \times 10^{-11}$ N m^2 kg^{-2}, Boltzmann constant (k_b)$= 1.38 \times 10^{-23}$m^2 kg s^{-2} K^{-1}, Stefan-Boltzmann constant (σ) $= 5.67 \times 10^{-8}$ Wm^{-2}K^{-4}, 1pc $= 3.09 \times 10^{16}$m, 1AU $= 1.5 \times 10^{11}$m, Mass of sun $\sim 2 \times 10^{30}$ kg, $R_\odot \sim 6.9 \times 10^8$m, $L_\odot = 3.8 \times 10^{26}$ W, $m_\odot = -26.74$, $M_\odot = 4.83$

7. In what wavelength region would you look for a star being born (T~ 1000K)? If the gas cloud out of which the star is being born has a size 3.2×10^{10} km and is at a distance of $10,000$ pc, what will be its angular size? What should be the diameter of the telescope that is capable of just resolving this gas cloud at the wavelength you estimated ?

8. If the luminosity of a white dwarf star is $10^{10}L_{\odot}$ what will be its absolute magnitude? If the apparaent magnitude of the white dwarf is 20, how far away is it?

9. If the luminosity of sun was constant throughout its lifetime, how long will the sun shine if the energy production was due to gravitational collapse? Assume constant density model for sun.

10. A galaxy is observed to have a recessional velocity of 1000 km/s, and the Hubble constant is measured to be $H_0 = 70$ km/s/Mpc. According to Hubble's law, what is the distance to this galaxy? If the Ca II K line has a laboratory wavelength of 3933$\mathring{A}$, what will be the wavelength of Ca II K line from this galaxy?

11. A tree fossil found in an excavation had 1/4th as much C^{14} as a living tree. If the half life of C^{14} is 5568 years, calculate the age of the tree fossil.

12. Thorium 228 emits α-particles of energy 5.42 Mev. Calculate the α disintegration energy. What will be the range of these α-particles in comparison to those of 8Mev energy?

PART C

Answer **FIVE** of the following questions by giving the correct reason or explanation. Each question carries 2 marks. $[5 \times 2 = 10]$

13. (a) Can gravitational waves be detected using an optical telescope?Why?
    (b) Does a black hole have a definite radius like a star?
    (c) A star has low temperature and high luminosity. How is it possible?
    (d) What are sunspots? How do we know that they have strong magnetic fields?
    (e) Can a Geiger-Muller counter distinguish between the type of ionizing radiation that enter it?
    (f) Why are photons called massless bosons?