K23U 0533

Reg. No. : ....

Name : ....

VI Semester B.Sc. Degree (CBCSS – OBE – Regular/Supplementary/ Improvement) Examination, April 2023
(2019 and 2020 Admissions)
DISCIPLINE SPECIFIC ELECTIVE IN PHYSICS
6B14PHY(5) : Plasma Physics

Time : 3 Hours Max. Marks : 40

SECTION – A

(Short answer questions – Answer **all** questions – **Each** question carries **1** mark.)

1. __________ equation gives the amount of ionization in a gas in thermal equilibrium.

2. In __________ energy conversion method a dense plasma jet is propelled across a magnetic field to generate electricity.

3. The temperature corresponding to 0.5 eV plasma is __________ (Boltzmann's constant, $k = 1.38 \times 10^{-23}$ J/K).

4. 1 tesla = ____________ gauss.

5. If B_o is the magnetic field at the centre and B_m is the maximum field in a magnetic mirror arrangement, then mirror ratio is

6. The relation connecting M, B and H is **(6×1=6)**

SECTION – B

(Short essay questions – **eight** questions – Answer **any six** – **Each** question carries **2** marks.)

7. What is meant by collective behavior in plasma ?

8. Write a short note on solid state plasmas.

P.T.O.

9. Give the equation for the drift of guiding center of a charged particle and resulting current density in the plasma caused by the force of gravity in the presence of a magnetic field B.

10. Discuss motion of a charged particle in a curved magnetic field and arrive at the expression for curvature drift of the guiding center of the charged particle.

11. Write down the Maxwell's equations in vacuum.

12. Write a short note on the equation of continuity for plasma particles.

13. Discuss equation of states for plasma.

14. Discuss collisions of charged fluid with neutral fluid in plasma. What is its effect on the fluid equation of motion ? **(6×2=12)**

SECTION – C

(Problems – **Six** questions – Answer **any four** questions – **Each** question carries **3** marks.)

15. Calculate the number density (no. of particles per unit volume) of an ideal gas at 0°C and atmospheric pressure P = 1.013×10^5 Nm^{-2}. (Boltzmann constant k = 1.38×10^{-23} J/K)

16. In a fusion reactor, the core of a small pellet of Deuterium and Tritium fuels is compressed to a density of 10^{33} m^{-3} at a temperature of 5×10^7 K. Estimate the Debye length and number of particles in a Debye sphere.

17. Compute the Larmor radius for a solar proton streaming with velocity 240 km per second perpendicular to a magnetic field of 5×10^{-5} Tesla.

18. Find the cyclotron frequency of electrons moving with a speed of 500 km/s making an angle of 45° with a magnetic field of strength 3×10^{-4} T.

19. Show that the magnetic moment of a charged particle gyrating in a magnetic field is $\mu = \frac{mv_\perp^2}{2B}$. Here $v_\perp$ is the component of velocity perpendicular to the magnetic field.

20. Derive dielectric permittivity assuming a uniform-plasma at low-frequency for transverse motions as $\varepsilon = \varepsilon_0 + \frac{\rho}{B^2}$. Here ρ is the mass density of plasma particles. **(4×3=12)**

SECTION – D

(Long essay – **Four** questions – Answer **any two** questions – **Each** question carries

5 marks)

21. Discuss the concept of Debye shielding and derive an expression for Debye length.

22. Discuss the motion of a charged particle in a region with a constant electric field in the x-z plane and a constant magnetic field in the z-direction. Arrive at the expression for the electric field drift velocity of the guiding center of the charged particle.

23. Discuss the motion of a charged particle in a time varying magnetic field. Show that the magnetic moment of the charged particle is invariant in slowly varying magnetic fields. Give one application of this property in the field of plasma.

24. Starting from the equation of motion for a single charged particle, derive the fluid equation of motion for plasma (without considering anisotropic pressure and neutral collisions)

$$mn\left|\frac{\partial u}{\partial t} + (u.\nabla)u\right| = qn(E + u \times B) \ .$$

(2×5=10)