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E–303

M. Sc. (First Semester)
EXAMINATION, Dec.-Jan., 2020-21

PHYSICS

Paper Third

(Electrodynamics and Plasma Physics)

Time : Three Hours] [*Maximum Marks : 80*

Note : Attempt all Sections as directed.

Section—A 1 each

(Objective/Multiple Choice Questions)

Note : Attempt all questions.

Choose the correct answer :

1. Which one is a correct Larmour formula ?

   (a) $\left(\frac{1}{4\pi \in_0}\right)\left(\frac{2q^3a^3}{3c^4}\right)$

   (b) $\left(\frac{1}{4\pi \in_0}\right)\left(\frac{2q^4a^4}{3c^2}\right)$

   (c) $\left(\frac{1}{4\pi \in_0}\right)\left(\frac{2q^5a^5}{3c}\right)$

   (d) None of the above

P. T. O.

2. Physical dimension of Plasma (L) should be :

   (a) $L >> \lambda$ Debye

   (b) $L = \lambda$ Debye

   (c) $L << \lambda$ Debye

   (d) None of the above

3. The relationship between the electric field $\vec{E}$ and potential difference V is :

   (a) $E = \vec{\nabla} \times V$

   (b) $E = -\nabla V + \frac{\partial V}{\partial t}$

   (c) $E = \nabla V$

   (d) None of the above

4. Which one of the following is a Lorentz invariant ?

   (a) Charge (q)

   (b) Space time interval $x^2 + y^2 + z^2 - c^2t^2$

   (c) Mass (M)

   (d) Both (a) and (b)

5. The Poynting vector for velocity and accelerating field are given by :

   (a) $S_v \propto \frac{1}{R^4}; S_a \propto \frac{1}{R^2}$

   (b) $S_v \propto \frac{1}{R^5}; S_a \propto \frac{1}{R^4}$

   (c) $S_v \propto \frac{1}{R^6}; S_a \propto \frac{1}{R^5}$

   (d) None of the above

6. Accelerated relativistic charged particle in magnetic field gives :

   (a) Cherenkov radiation

   (b) Bremsstrahlung radiation

   (c) Both (a) and (b)

   (d) None of the above

7. Which one is correct relation ?

   (a) $\vec{B} = \vec{\nabla} \times \vec{A}$ and $\vec{E} = -\nabla\phi - \frac{\partial \bar{A}}{\partial t}$

   (b) $\vec{B} = \nabla \times \vec{A}$ and $\vec{E} = \nabla\phi + \frac{\partial \bar{A}}{\partial t}$

   (c) $\vec{B} = \nabla \times \vec{A}$ and $\vec{E} = -\nabla\phi + \frac{\partial \bar{A}}{\partial t}$

   (d) None of the above

8. A plasma is characterized by a collection of :

   (a) Gases of low velocity

   (b) Ions and gases of high density

   (c) Ions and gases of low density

   (d) Gases of high velocity

9. Which one of the following current densities $\vec{J}$ can generate the magnetic vector patential $\vec{A} = y^2\hat{i} + x^2\hat{j}$?

   (a) $\frac{2}{\mu_0} x\hat{i} + y\hat{j}$

(b) $\frac{-2}{\mu_0}\ \hat{i} - \hat{j}$

(c) $\frac{-2}{\mu_0}\ \hat{i} + \hat{j}$

(d) None of the above

10. Alfven velocity is given by :

(a) $v_A = \left(\frac{B_0^2}{2}\right)^{V_2}$

(b) $v_A = \left(\frac{1}{\mu_0 \rho_m}\right)^{V_2}$

(c) $v_A = \frac{B}{\sqrt{\mu_0 \rho_m}}$

(d) $v_A = \left(\frac{\mu_0 \rho_m}{B_0^2}\right)^{V_2}$

11. The electromagnetic field equation in terms of electromagnetic patential (A and ϕ) is represented by an equation :

(a) $\nabla^2 \phi \vec{A} + \frac{\partial}{\partial t} \text{div}\ \phi = \frac{-\rho}{\varepsilon}$

(b) $\nabla^2 + \frac{\partial}{\partial t}\left(\text{div}\ \vec{A}\right) = \frac{-\rho}{\varepsilon}$

(c) $\nabla^2 \phi + \frac{\partial}{\partial t}\left(\text{div}\ \vec{A}\right) = \frac{\rho}{\varepsilon_0}$

(d) None of the above

12. Equation of magnetohydrodynamics is given by :

(a) $\rho \frac{dV}{dt} = -\vec{\nabla} \rho + J \times B$

(b) $\frac{dV}{dt} = \vec{\nabla} \rho + \vec{J}$

(c) $\rho \frac{dV}{dt} = \vec{\nabla} J + \rho$

(d) None of the above

13. Electric field component of an electromagnetic wave is given by :

$$\vec{E} = 30 \cos\left(2\pi \times 10^8 t - \frac{2\pi}{3} x \right) \hat{y} \, E$$

Then phase velocity of wave is :

(a) $2\pi \times 10^8$ m/sec

(b) 10^8 m/sec

(c) 3×10^8 m/sec

(d) 30×10^8 m/sec

14. The electric patential due to a linear quadrupole varies inversely with :

(a) r^3

(b) r^2

(c) r

(d) None of the above

15. In the case of field of arbitary moving charges, the magnetic field vector such that :

(a) $\vec{H} = \frac{\hat{n} \times \vec{E}}{\mu_0 c}$

(b) $\vec{H} = \frac{\hat{n} \times \vec{E}}{\mu_0 c^3}$

(c) $\vec{H} = \frac{\mu_0 c^2}{\hat{n} \times \vec{E}}$

(d) $\vec{H} = \frac{\mu_0 c^3}{\hat{n} \times \vec{E}}$

16. In the Cherenkov radiation :

(a) $v < \frac{c}{\sqrt{\epsilon \omega}}$

(b) $v > \frac{c}{\sqrt{\epsilon \omega}}$

(c) $v > \frac{\sqrt{\epsilon \omega}}{c}$

(d) None of the above

17. The force on a charge q placed in a uniform electric field $\vec{E}$ will be :

(a) qE

(b) qE + qB

(c) q/E

(d) None of the above

18. The power radiated by an electric dipole is proportional to the frequency :

(a) ω

(b) ω^2

(c) ω^3

(d) ω^4

19. The electric and magnetic fields share the energy of electromagnetic wave in ratio :

(a) 1 : 1

(b) 1 : 2

(c) 1 : 3

(d) 1 : 4

20. The velocity of transverse wave in a stretched string is :

(a) $v = \sqrt{\frac{\rho}{T}}$

(b) $v = \sqrt{\frac{T}{\rho}}$

(c) $v = \sqrt{\frac{T^2}{\rho^2}}$

(d) None of the above

Section—B 2 each

(Very Short Answer Type Questions)

Note : Attempt all questions.

1. Define the retarded potential and retarded time.
2. Define the adiabatic invariant.
3. What is Cherenkov radiation ?
4. What is magneto sonic wave ?

5. What is magnetic mirror effect ?
6. Define vector and scalar patential.
7. What is Lineard-Wiechert patential ?
8. Write the Boltzmann equations.

Section—C 3 each

(Short Answer Type Questions)

Note : Attempt all questions.

1. Explain the mathematical properties of the space-time in special relativity.
2. Explain the elementary concept of plasma kinetic theory.
3. Explain the angular distribution of radiation emitted by an accelerated charge.
4. Explain the magnetic viscocity and magnetic pressure.
5. Explain the spectrum of synchrotron radiation.
6. Define the non-uniform magnetostatic field.
7. Show that $E^2 = p^2 c^2$ is a Lorentz invariant quantity.
8. Explain the fundamental equations of magneto-hydrodynamics.

Section—D 5 each

(Long Answer Type Questions)

Note : Attempt any *four* questions.

1. Derive the Green's function for the wave equation.
2. Explain the motion of a charged particle in electromagnetic field in the case of non-uniform E and B field.
3. Derive the Lienard-Wiechart potential and field for a point charge.
4. Explain the emission from single-speed electrons, thermal Bremsstralung emission and absorption.
5. Explain the plasma confinement schemes.