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O.M.R. Serial No. | | | | | | | | |

Question Booklet Number

M.Sc. (SEM.-III) (NEP) (SUPPLE.)EXAMINATION, 2024-25

PHYSICS

(Classical Electrodynamics and Plasma Physics)

Paper Code							
B	0	1	0	9	0	1	T

Question Booklet Series
A

Time : 1 : 30 Hours **Max. Marks : 75**

Instructions to the Examinee :

1. Do not open the booklet unless you are asked to do so.
2. The booklet contains 100 questions. Examinee is required to answer 75 questions in the OMR Answer-Sheet provided and not in the question booklet. All questions carry equal marks.
3. Examine the Booklet and the OMR Answer-Sheet very carefully before you proceed. Faulty question booklet due to missing or duplicate pages/questions or having any other discrepancy should be got immediately replaced.
4. Four alternative answers are mentioned for each question as - A, B, C & D in the booklet. The candidate has to choose the correct / answer and mark the same in the OMR Answer-Sheet as per the direction :

(Remaining instructions on last page)

परीक्षार्थियों के लिए निर्देश :

1. प्रश्न-पुस्तिका को तब तक न खोलें जब तक आपसे कहा न जाए।
2. प्रश्न-पुस्तिका में 100 प्रश्न हैं। परीक्षार्थी को 75 प्रश्नों को केवल दी गई OMR आन्सर-शीट पर ही हल करना है, प्रश्न-पुस्तिका पर नहीं। सभी प्रश्नों के अंक समान हैं।
3. प्रश्नों के उत्तर अंकित करने से पूर्व प्रश्न-पुस्तिका तथा OMR आन्सर-शीट को सावधानीपूर्वक देख लें। दोषपूर्ण प्रश्न-पुस्तिका जिसमें कुछ भाग छपने से छूट गए हों या प्रश्न एक से अधिक बार छप गए हों या उसमें किसी अन्य प्रकार की कमी हो, उसे तुरन्त बदल लें।
4. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार सम्भावित उत्तर- A, B, C एवं D हैं। परीक्षार्थी को उन चारों विकल्पों में से सही उत्तर छाँटना है। उत्तर को OMR उत्तर-पत्रक में सम्बन्धित प्रश्न संख्या में निम्न प्रकार भरना है :

(शेष निर्देश अन्तिम पृष्ठ पर)

1. If ϕ and A are scalar and vector potentials then the Lorentz gauge condition is :

(A) $\vec{\nabla}\cdot\vec{A}=0$

(B) $\vec{\nabla}\cdot\vec{A}=\mu_0\varepsilon_0\dfrac{d\phi}{dt}$

(C) $\vec{\nabla}\cdot\vec{A}=-\mu_0\varepsilon_0\dfrac{d\phi}{dt}$

(D) $\vec{\nabla}\cdot\vec{A}=\pm\mu_0\varepsilon_0\dfrac{d\phi}{dt}$

2. The electric and magnetic fields in terms of scalar and vector potentials for accelerated charge particle are :

(A) $\vec{E}=-\vec{\nabla}\phi-\dfrac{d\vec{A}}{dt};\ \vec{B}=\vec{\nabla}\times\vec{A}$

(B) $\vec{E}=-\vec{\nabla}\phi+\dfrac{d\vec{A}}{dt};\ \vec{B}=\vec{\nabla}\times\vec{A}$

(C) $\vec{E}=+\vec{\nabla}\phi-\dfrac{d\vec{A}}{dt};\ \vec{B}=\vec{\nabla}\times\vec{A}$

(D) $\vec{E}=+\vec{\nabla}\phi+\dfrac{d\vec{A}}{dt};\ \vec{B}=\vec{\nabla}\times\vec{A}$

3. The em field equations in terms of potentials under Lorentz gauge condition is :

(A) $\nabla^2\phi+\dfrac{1}{c^2}\dfrac{d^2\phi}{dt^2}=-\dfrac{\rho}{\varepsilon_0}$ and

$$\nabla^2\vec{A}+\frac{1}{c^2}\frac{d^2\vec{A}}{dt^2}=-\mu_0\vec{J}$$

(B) $\nabla^2\phi-\dfrac{1}{c^2}\dfrac{d^2\phi}{dt^2}=\dfrac{\rho}{\varepsilon_0}$ and

$$\nabla^2\vec{A}-\frac{1}{c^2}\frac{d^2\vec{A}}{dt^2}=\mu_0\vec{J}$$

(C) $\nabla^2\phi-\dfrac{1}{c^2}\dfrac{d^2\phi}{dt^2}=-\dfrac{\rho}{\varepsilon_0}$ and

$$\nabla^2\vec{A}-\frac{1}{c^2}\frac{d^2\vec{A}}{dt^2}=-\mu_0\vec{J}$$

(D) $\nabla^2\phi+\dfrac{1}{c^2}\dfrac{d^2\phi}{dt^2}=\dfrac{\rho}{\varepsilon_0}$ and

$$\nabla^2\vec{A}+\frac{1}{c^2}\frac{d^2\vec{A}}{dt^2}=\mu_0\vec{J}$$

4. Which of the following violates causality in electrodynamics?

(A) Retarded potential

(B) Liénard–Wiechert potential

(C) Advanced potential

(D) Both (A) and (B)

5. If source starts moving from point (0, t') relativistically with velocity $\beta\left(=v/C\right)$ and fields are observed at point (r, t) then under casuality principle in classical electrodynamics, the true statement :

(A) Field potentials are retarded potential

(B) Effective distance between source and field point is $\left(r-\vec{\beta}\vec{r}\right)$

(C) Retarded time $t'=t-r/c$

(D) All of the above

6. Which of the following potentials is consistent with special relativity?

(A) Retarded potential

(B) Advanced potential

(C) Both retarded and advanced potentials

(D) None of these

7. The advanced potential describes the field at time t in terms of the source distribution at:

(A) t

(B) $t - r / c$

(C) $t + r / c$

(D) $t \pm r / c$

8. Which statement is true for advanced potential?

(A) Present fields depend on future source behavior

(B) Obey causality principle and $t' = t - r / c$

(C) Does not obey causality principle and $t + r / c$

(D) Both (A) and (C)

9. The advanced Green's function of the wave equation is proportional to:

(A) $\delta(t)$

(B) $\delta(t - r / c)$

(C) $\delta(t + r / c)$

(D) $\delta(t \pm r / c)$

10. If $[r]$ represents effective distance between source and observer then Retarded scalar potential is given by equation :

(A) $\phi(r,t) = \dfrac{1}{4\pi\varepsilon_0}\int \dfrac{\rho(r', t - r/c)}{[r]} d\tau'$

(B) $\phi(r,t) = \dfrac{1}{4\pi\varepsilon_0}\int \dfrac{\rho(r', t + r/c)}{[r]} d\tau'$

(C) $\phi(r,t) = \dfrac{\mu_0}{4\pi}\int \dfrac{J(r', t + r/c)}{[r]} d\tau'$

(D) $\phi(r,t) = \dfrac{\mu_0}{4\pi}\int \dfrac{J(r', t - r/c)}{[r]} d\tau'$

11. Which is not true for Liénard-Wiechert potentials?

(A) This potential satisfies the Maxwell's equations in the Lorenz gauge condition

(B) It is retarded potentials with velocitydependent corrections

(C) Both the LW scalar and vector potentials are independent and can not be correlated

(D) It is used in evaluation of Electromagnetic fields produced by moving point charges

12. The relation in scalar and vector Lienard-Wiechert potentials ϕ and A is :

(A) $\vec{A} = \phi\vec{\beta};\ \beta = v / c$

(B) $\vec{A} = \phi\vec{\beta} / c;\ \beta = v / c$

(C) $\vec{A} = \phi\vec{\beta} / c^2;\ \beta = v / c$

(D) ϕ and A has nor relation

13. The expression for vector Lienard-Wiechert potentials A for linearly accelerated point charge is :

(A) $\vec{A} = \frac{\mu_0}{4\pi} \frac{q\vec{v}}{(r - \vec{\beta}\cdot\vec{r})}; \beta = v / c$

(B) $\vec{A} = \frac{1}{4\pi\varepsilon_0 c} \frac{q\vec{\beta}}{(r - \vec{\beta}\cdot\vec{r})}; \beta = v / c$

(C) Both (A) and (B)

(D) None of the above

14. The inductive and radiation fields obtained by LW potential due arbitrarly accelerated charge particle are proportional to :

(A) $r^{-2}; r^{-1}$

(B) $r^{-1}; r^{-2}$

(C) $r^{-2}; r^{-3}$

(D) $r^{-3}; r^{-2}$

15. Let a point charge q is linearly accelerated and has velocity $v(= c\beta)$ at any instant. If the fields are observed at (r_0, α) then expression of electric field is :

(A) $\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{q\vec{r}_0}{r_0^3} \frac{\left(1-\beta^2\right)}{\left(1-\beta^2 \sin^2\alpha\right)}$

(B) $\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{q\vec{r}_0}{r_0^3} \frac{\left(1-\beta^2\right)}{\left(1-\beta^2 \sin^2\alpha\right)^2}$

(C) $\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{q\vec{r}_0}{r_0^3} \frac{\left(1-\beta^2\right)}{\left(1-\beta^2 \sin^2\alpha\right)^{2/3}}$

(D) $\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{q\vec{r}_0}{r_0^3} \frac{\left(1-\beta^2\right)}{\left(1-\beta^2 \sin^2\alpha\right)^{3/2}}$

16. Let a point charge q is linearly accelerated and has velocity $v(\approx c)$. If the ratio of electric field at $\left(r_0, 90^{\circ}\right)$ and $\left(r_0, 0^{\circ}\right)$ is equal to :

(A) 0

(B) 1

(C) $\sqrt{1-\beta^2}$

(D) ∞

17. The expression of radiative electric field due to arbitrarly accelerated charge particle is :

(A) $\vec{E}_r = \frac{q}{4\pi\varepsilon_0} \frac{\vec{r}\times(\vec{r}-\vec{\beta}r)\times\dot{\vec{\beta}}}{(r-\vec{\beta}\cdot\vec{r})^3}$

(B) $\vec{E}_r = \frac{q}{4\pi\varepsilon_0 c} \frac{\vec{r}\times(\vec{r}-\vec{\beta}r)\times\dot{\vec{\beta}}}{(r-\vec{\beta}\cdot\vec{r})^3}$

(C) $\vec{E}_r = \frac{q}{4\pi\varepsilon_0} \frac{\vec{r}\times(\vec{r}-\vec{\beta}r)\times\dot{\vec{\beta}}}{(r-\vec{\beta}\cdot\vec{r})^{3/2}}$

(D) $\vec{E}_r = \frac{q}{4\pi\varepsilon_0 c} \frac{\vec{r}\times(\vec{r}-\vec{\beta}r)\times\dot{\vec{\beta}}}{(r-\vec{\beta}\cdot\vec{r})^{3/2}}$

18. The relation in radiative electric and magnetic field is :

(A) $\vec{\beta}_r = \frac{\vec{n} \times \vec{E}_r}{c}$

(B) $\vec{\beta}_r = \frac{\vec{n} \times \vec{E}_r}{c^2}$

(C) $\vec{E}_r = \frac{\vec{n} \times \vec{B}_r}{c}$

(D) $\vec{E}_r = \frac{\vec{n} \times \vec{B}_r}{c^2}$

19. Which statement true for non-relativistic accelerated charge particle?

(A) Larmor formula is valid for total radiated power

(B) Total power is proportional to square of acceleration

(C) Angular power distribution is proportional to $\sin^2\theta$ (θ is angle between wave propagation vector and acceleration)

(D) All of the above

20. Which one is Larmor formula?

(A) $\frac{q^2\dot{v}^2}{4\pi\varepsilon_0 c^2}$

(B) $\frac{q^2 v^2}{4\pi\varepsilon_0 c^3}$

(C) $\frac{q^2\dot{v}^2}{6\pi\varepsilon_0 c^3}$

(D) $\frac{q^2 v^2}{6\pi\varepsilon_0 c^2}$

21. The Larmor Formula is valid for :

(A) Radiation by non-relativistive accelerated charge particle

(B) Bremsstrahulung radiation

(C) Synchrotron radiation

(D) All of the above

22. What is practical energy limit of circular accelerator ?

(A) eV (B) keV

(C) MeV (D) BeV

23. The example of Bremsstrahlung radiation is :

(A) γ-ray

(B) X-ray

(C) IR-radiation

(D) UV-radiation

24. Which statement is true for Lienard formula?

(A) It is expression for total power radiated by relativistically accelerated charge particle and it converts in Larmor Formula for $\beta \to 0$

(B) It converts into total power radiated by Bremsstrahlung radiation when β is parallel to $\dot{\beta}$

(C) It converts into total power radiated by synchrotron radiation when β is perpendicular to $\dot{\beta}$

(D) All of the above

25. The expression of total power radiated by circular accelerator is :

(A) $\frac{1}{4\pi\varepsilon_0}\frac{2q^2\dot{v}^2\gamma^2}{3c^2}$

(B) $\frac{1}{4\pi\varepsilon_0}\frac{2q^2\dot{v}^2\gamma^4}{3c^3}$

(C) $\frac{1}{4\pi\varepsilon_0}\frac{2q^2\dot{v}^2\gamma^6}{3c^4}$

(D) None of the above

26. For synchrotron radiation, the angular power distribution :

(A) is aligned along velocity direction of charge particle as $\beta \to 1$ and is aligned both backward and forward direction of motion of charge for $\beta \to 0$

(B) is aligned along acceleration direction of charge particle as $\beta \to 1$ and is aligned along velocity direction of charge for $\beta \to 0$

(C) is aligned along velocity direction of charge particle as $\beta \to 1$ and is alined along acceleration direction of charge for $\beta \to 0$

(D) is always aligned along acceleration direction of charge particle

27. The statement not true for Thomson scattering is :

(A) It is scattering of low-energy photons by free electrons

(B) Thomson scattering cross-section is equal to $(8\pi/3)r_0^2$ where $r_{\mathbf{0}}$ is classical electron radius

(C) The differential cross-section for Thomson scattering depends on the scattering angle θ as, $(r_0^2/2)(1+\cos^2\theta)$

(D) In this neither energy nor momentum is conserved

28. What is plasma formation condition?

(A) Sufficient Ionization of gas at high temperature with Quasi-neutrality

(B) Its length should be greater or equal to Debye length and number of particles inside a Debye sphere must be $\gg 1$

(C) Plasma frequency should be much higher than the collision frequency

(D) All of the above

29. First moment of Boltzmann equation provides :

(A) Equation of continuity

(B) Force equation

(C) Energy equation

(D) All of the above

30. Angular Frequency of plasma oscillation is :

(A) $\sqrt{\dfrac{m\varepsilon_0}{ne^2}}$

(B) $\sqrt{\dfrac{ne^2}{m\varepsilon_0}}$

(C) $\sqrt{\dfrac{me^2}{n\varepsilon_0}}$

(D) $\sqrt{\dfrac{\varepsilon_0 e^2}{mn}}$

31. The Debye length for plasma at temperature T is :

(A) The distance at which potential becomes zero

(B) equal to $\left\{\left(\varepsilon_0 KT\right)/\left(2ne^2\right)\right\}^{1/2}$

(C) equal to $\left\{\left(\varepsilon_0 KT\right)/\left(mne^2\right)\right\}^{1/2}$

(D) Both (A) and (B)

32. Which equation represents conservation of momentum in palsma?

(A) $\rho_m = \dfrac{d\vec{u}}{dt} = \vec{J} \times \vec{\beta} + \overline{\overline{p}}$

(B) $\rho_m = \dfrac{d\vec{u}}{dt} = -\vec{J} \times \vec{\beta} - \overline{\overline{p}}$

(C) $\rho_m = \dfrac{d\vec{u}}{dt} = \vec{J} \times \vec{\beta} - \overline{\overline{p}}$

(D) $\vec{u}\dfrac{d\rho_m}{dt} = \vec{J} \times \vec{\beta} - \overline{\overline{p}}$

33. If plasma is placed in external magnetic field then magnetic pressure and tension experienced by plasma are:

(A) $B^2/\mu_0;\ B^2/2\mu_0$

(B) $B^2/2\mu_0;\ B^2/\mu_0$

(C) $2B^2/3\mu_0;\ 3B^2/2\mu_0$

(D) $3B^2/2\mu_0;\ 2B^2/3\mu_0$

34. Which method can be used to confine the plasma ?

(A) By static electric or magnetic field

(B) By using magnetic mirror

(C) By pinch effect

(D) All of the above

35. What is order range of pinch current to confine the plasma?

(A) 10^{-2}A–10^{o}A

(B) 10^{0}A–10^{1}A

(C) 10^{2}A–10^{3}A

(D) 10^{4}A–10^{6}A

36. Velocity of Alfven wave is given by :

(A) $\sqrt{B^2/(\mu_0\rho)}$

(B) $\sqrt{B^2/(2\mu_0\rho)}$

(C) $\sqrt{(\mu_0\rho)/B^2}$

(D) $\sqrt{(2\mu_0\rho)/B^2}$

37. The basic assumption of ideal MHD is:

(A) Infinite resistivity

(B) Infinite conductivity

(C) Finite resistivity

(D) Zero pressure plasma

38. Which equation represents the frozen-in condition in ideal MHD?

(A) $\vec{\nabla} \cdot \vec{\beta} = 0$

(B) $\rho_m \frac{d\,\vec{u}}{dt} = \vec{J} \times \vec{\beta} - \overline{\overline{p}}$

(C) $\frac{d\,\vec{B}}{dt} = \vec{\nabla} \times \vec{u} \times \vec{B}$

(D) All of the above

39. The restoring force in an Alfvén wave is provided by:

(A) Pressure gradient

(B) Gravity

(C) Magnetic tension

(D) Electric field

40. Which is not true for Alfven wave?

(A) It is a transverse wave

(B) Its phase velocity depends on plasma density and magnetic field

(C) Wave vector is parallel to magnetic field in it

(D) Its phase velocity is equal to magnetosonic velocity for sound velocity<<Alfven wave velocity

41. Which is true for magnetosonic wave?

(A) The restoring force in magnetosonic waves is mainly combination of pressure gradient and magnetic field

(B) The dispersion relation for fast magnetosonic wave is $\omega^2 = K^2 \left(V_s^2 + V_A^2\right)$

(C) The slow magnetosonic wave velocity is approximately equal to $V_s V_A / \sqrt{V_s^2 + V_A^2}$

(D) All of the above

42. If sound velocity is much less than Alfven velocity for plasma then magnetosonic velocity tend to:

(A) Alfven wave velocity

(B) Sound velocity

(C) Infinite

(D) Zero

43. In MHD, magnetic Reynolds number R_m represents:

(A) Ratio of magnetic diffusion to advection

(B) Ratio of magnetic advection to diffusion

(C) Ratio of kinetic to magnetic pressure

(D) Ratio of thermal to magnetic energy

44. If magnetic field is frozen in Plasma then Reynolds number is :

(A) 1

(B) >>1

(C) <<1

(D) Zero

45. Which of the following is a compressional wave?

(A) Alfvén wave

(B) Magnetosonic wave

(C) Both (A) and (B)

(D) Neither

46. If J_μ and A_μ are current density and potential four vectors then equation of continuity and Lorentz gauge condition in tensor form can be written as :

(A) $\partial_\mu J_\mu = 0; \partial_\mu A_\mu = 0$

(B) $\partial_\mu A_\mu = 0; \partial_\mu J_\mu = 0$

(C) $\partial_\mu J_\mu = -\frac{\partial\rho}{\partial t}; \partial_\mu A_\mu = -\varepsilon_0 J_\mu$

(D) None of the above

47. If J_μ and A_μ are current density and potential four vectors while is ∂_μ differential operator in Mikowski space then Maxwell equation under Lorentz condition in tensor form is written as :

(A) $\partial_\mu \partial_\mu A_\mu = -\varepsilon_0 J_\mu$

(B) $\partial_\mu \partial_\mu A_\mu = -\mu_0 J_\mu$

(C) $\partial_\mu A_\mu = -\varepsilon_0 J_\mu$

(D) $\partial_\mu A_\mu = -\mu_0 J_\mu$

48. The position four vector is given by :

(A) $r_\mu = (\vec{r}, ct)$

(B) $r_\mu = (\vec{r}, ict)$

(C) Both (A) and (B) are correct. The first one follows Pythagorean theorems while other one hyperbolian theorem.

(D) Both (A) and (B) are correct. The first one follows hyperbolian theorems while other one Pythagorean theorem.

49. If momentum four vector is given by $p_\mu = (\vec{p}, iE/c)$ then $p_\mu p_\mu$ is equal to :

(A) $p^2 - (E/c)^2$

(B) $p^2 + (E/c)^2$

(C) $p^2 - (E/c)^2 - 2ipE/c$

(D) $p^2 - (E/c)^2 + 2ipE/c$

50. Inner product of velocity four vector is equal to :

(A) c

(B) c^2

(C) c^3

(D) c^4

51. The Minkowski metric tensor in the signature (-,+,+,+) has diagonal elements :

(A) (–1, 1, 1, 1)

(B) (1, –1, –1, –1)

(C) ($-c^2$, 1, 1, 1)

(D) (c^2, –1, –1, –1)

52. If the position four-vector is given by $r_\mu = (\vec{r}, ct)$ and metric tensor is $g_{\mu\nu}$ then distance between two points will be :

(A) $r^2 - c^2t^2$

(B) $c^2t^2 - r^2$

(C) $r^\mu g_{\mu\nu} r^\nu$

(D) Both (A) and (C)

53. The invariance condition of Minkowski metric $g_{\mu\nu}$ in Matrix form is:

(A) $\Lambda^T g \Lambda = g$

(B) $\left(\Lambda^{-1}\right)^T g \Lambda^{-1} = g$

(C) $\Lambda^T g \Lambda^{-1} = g$

(D) Both (A) and (B)

54. Minkowski Space follows which of the following:

(A) Pythagorean theorem

(B) Hyperbolean theorem

(C) Routh's theorem

(D) All of the above

55. In relativity, Causality states that:

(A) Cause must preced its effect in all inertial reference frames

(B) Effect must preced its cause in all inertial reference frames

(C) Cause and effect happens at same moment in all inertial reference frames

(D) None of the above

56. Which statement is true for events in Minkowski space under consideration of the light cone?

(A) Time like events, $x^2 + y^2 + z^2 < c^2t^2$

(B) Space like events, $x^2 + y^2 + z^2 > c^2t^2$

(C) Light like events, $x^2 + y^2 + z^2 = c^2t^2$

(D) All of the above

57. The Lorentz transformation in tensor form is :

(A) $r'_\mu = \Lambda_{\mu\nu} r_\nu$

(B) $r'_\mu = g_{\mu\nu} r_\nu$

(C) $r'_\mu = g^{\mu\nu} \Lambda_{\alpha\nu} r^\nu$

(D) $r'_\mu = g_{\mu\alpha} \Lambda^{\alpha\nu} r_\nu$

58. The four-momentum of a particle with mass *m* is:

(A) $p^\mu = (\vec{p}, \gamma c E)$

(B) $p^\mu = \left(\vec{p}, i\frac{E}{c}\right)$

(C) $p^\mu = m u^\mu$

(D) Both (B) and (C) are correct

59. The current density four-vector j^μ satisfies:

(A) $\partial_\mu j^\mu = 0$

(B) $j^\mu = \rho u^\mu$

(C) $j^\mu = (\vec{J}, ic\rho)$

(D) All of the above

60. The potential four vector is given by:

(A) $A_\mu = \left(\vec{A}, i\phi / c\right)$

(B) $A_\mu = \left(\vec{A}, ic\phi\right)$

(C) $A_\mu = \left(\vec{A}, \gamma\phi / c\right)$

(D) $A_\mu = \left(\vec{A}, \gamma c\phi\right)$

61. A proper Lorentz transformation satisfies:

(A) $\det(\Lambda) = +1$ and $\Lambda_0^0 > 1$

(B) $\det(\Lambda) = -1$ and $\Lambda_0^0 > 1$

(C) $\det(\Lambda) = +1$ only

(D) $\Lambda_0^0 > 1$ only

62. The Lorentz group consists of all transformations that preserve:

(A) Space volume

(B) Phase space

(C) Minkowski metric

(D) Hamiltonian

63. An orthochronous Lorentz transformation satisfies:

(A) $\Lambda_0^0 > 1$

(B) $\Lambda_0^0 < 1$

(C) $\Lambda_0^0 = 1$

(D) None of the above

64. Under a Lorentz boost in the x-direction, the y-component of electric field :

(A) Remains unchanged

(B) Transforms as $E'_y = \gamma E_y$

(C) Transforms as $E'_y = \gamma\left(E_y - vB_z\right)$

(D) Becomes zero

65. A boost in the x-direction with rapidity φ has matrix elements:

(A) $\Lambda_0^0 = \cosh\varphi,\ \Lambda_1^0 = \sinh\varphi$

(B) $\Lambda_0^0 = \sinh\varphi,\ \Lambda_1^0 = \cosh\varphi$

(C) $\Lambda_0^0 = \gamma,\ \Lambda_1^0 = -\gamma\beta$

(D) Both (A) and (C) are equivalent

66. A Lorentz transformation with $\det A = \pm 1$ and $\Lambda_0^0 \geq 1$ is called :

(A) Improper Lorentz transformation

(B) Proper orthochronous Lorentz transformation

(C) Parity transformation

(D) Time reversal

67. Lorentz boosts correspond to changes in:

(A) Spatial rotation

(B) Inertial frame velocity

(C) Energy quantization

(D) Quantum phase

68. The Poincaré group is obtained by extending the Lorentz group with:

(A) Rotations

(B) Boosts

(C) Space-time translations

(D) Parity transformations

69. Which type of Lorentz group is formed under time reversal and parity transformation?

(A) Proper orthochronous Lorentz group

(B) Improper orthochronous Lorentz group

(C) Proper non-orthochronous Lorentz group

(D) Improper non-orthochronous Lorentz group

70. An orthochronous Lorentz transformation preserves:

(A) The direction of time

(B) Spatial orientation

(C) Both time and space orientation

(D) Neither time nor space orientation

71. The electromagnetic field tensor F_{uv} is given by :

(A) $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$; $\mu, \nu = 1,2,3,4$

(B) $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\mu A_\nu$; $\mu, \nu = 1,2,3,4$

(C) $F_{\mu\nu} = \partial_\mu A_\mu - \partial_\nu A_\nu$; $\mu, \nu = 1,2,3,4$

(D) $F_{\mu\nu} = \partial_\nu A_\nu - \partial_\mu A_\mu$; $\mu, \nu = 1,2,3,4$

72. The electromagnetic field tensor is a :

(A) Symmetric tensor

(B) Antisymmetric tensor

(C) Diagonal Tensor

(D) Identity Tensor

73. If position and potential four vectors are defined by $r_\mu = (x, y, z, ict)$ and $A_\mu = (A_x, A_y, A_z, i\phi / c)$ respectively, then which component of em field tensor defines B_x, B_y and B_z?

(A) F_{12}, F_{23}, F_{31}

(B) F_{23}, F_{31}, F_{12}

(C) F_{31}, F_{12}, F_{23}

(D) F_{14}, F_{24}, F_{34}

74. If position and potential four vectors are defined by $r_\mu = (x, y, z, ict)$ and $A_\mu = (A_x, A_y, A_z, i\phi / c)$ respectively, then em field tensor components F_{41}, F_{42} and F_{43} are equal to :

(A) $iE_x / c, iE_y / c, iE_z / c$

(B) $-iE_x / c, -iE_y / c, -iE_z / c$

(C) $-B_x, -B_y, -B_z$

(D) $\gamma B_x, \gamma B_y, \gamma B_z$

75. The tensor form of Maxwell equation under Lorentz transformation is :

(A) Always variant

(B) Always invariant

(C) Variant only along boost

(D) Invariant only perpendicular to boost

76. Which statement for Lorentz transformation of electric and magnetic field is true?

(A) The component parallel to the boost direction is invariant

(B) The perpendicular components to the boost direction are variant

(C) Product of electric and magnetic field is always invariant

(D) All of the above

77. If r_μ, u_ν, p_μ and $F_{\mu\nu}$ are position, velocity, momentum and em field tensor respectively while proper time $d\tau = dt/\gamma$ then Lorentz force eqution in tensor form can be written as :

(A) $\dfrac{dp_\mu}{d\tau} = qF_{\mu\nu}u_\nu$

(B) $\dfrac{dp_\mu}{dt} = qF_{\mu\nu}u_\nu$

(C) $\dfrac{dp_\mu}{dt} = \gamma qF_{\mu\nu}u_\nu$

(D) $\dfrac{dp_\mu}{d\tau} = \gamma qF_{\mu\nu}u_\nu$

78. The time component of Lorentz force equation in tensor form provides :

(A) Expression of Lorentz force

(B) Expression of magnetic force

(C) Rate of change of energy is equal to force flux.

(D) Both (A) and (C)

79. A charge q is moving with velocity v and associated scalar and vector potentials are ϕ and A then generalized momentum and potential energy are respectively :

(A) $m\vec{v} + q\vec{A}$ and $q(\phi - \vec{v}\cdot\vec{A})$

(B) $m\vec{v} - q\vec{A}$ and $q(\phi + \vec{v}\cdot\vec{A})$

(C) $m\vec{v} + q\vec{A}$ and $q(\phi + \vec{v}\cdot\vec{A})$

(D) $m\vec{v} - q\vec{A}$ and $q(\phi - \vec{v}\cdot\vec{A})$

80. The expression of Lagrangian for non-relativistic particle in em field is :

(A) $L = mv^2/2 - q\phi - q\vec{v}\cdot\vec{A}$

(B) $L = mv^2/2 - q\phi + q\vec{v}\cdot\vec{A}$

(C) $L = (m\vec{v} + q\vec{A})^2/2 - q\phi + q\vec{v}\cdot\vec{A}$

(D) $L = (m\vec{v} - q\vec{A})^2/2 - q\phi - q\vec{v}\cdot\vec{A}$

81. The expression of Hamiltonian for non-relativistic particle in em field is:

(A) $H = \left(\vec{p} - q\vec{A}\right)^2/2m - q\phi$

(B) $H = \left(\vec{p} + q\vec{A}\right)^2/2m + q\phi$

(C) $H = \left(\vec{p} - q\vec{A}\right)^2/2m + q\phi$

(D) $H = \left(\vec{p} + q\vec{A}\right)^2/2m - q\phi$

82. The expression of Lagrangian for relativistic particle in em field is :

(A) $L = -\frac{m_0 c^2}{\gamma} - q(\phi - \vec{v} \cdot \vec{A})$

(B) $L = -\frac{m_0 c^2}{\gamma} + q(\phi - \vec{v} \cdot \vec{A})$

(C) $L = -\frac{m_0 c^2}{\gamma} + \frac{q}{\gamma} v_\alpha A^\alpha ; \alpha = 1,2,3,4$

(D) Both (A) and (C)

83. The expression of Hamiltonian for relativistic particle in em field is :

(A) $H = m_0 c^2 + q\phi$

(B) $H = (\vec{p} - q\vec{A})c + q\phi$

(C) $H = \sqrt{(\vec{p} - q\vec{A})^2 c^2 + m_0^2 c^4} + q\phi$

(D) $H = \sqrt{(\vec{p} + q\vec{A})^2 c^2 + m_0^2 c^4} - q\phi$

84. If sources are absent and only field are present then the lagrangian density in CGS system is given by ($F_{\mu\nu}$ - em field tensor :

(A) $\ell = -\frac{1}{4\mu_0} F_{\mu\nu} F^{\mu\nu}$

(B) $\ell = -\frac{1}{16\pi} F_{\mu\nu} F^{\mu\nu}$

(C) $\ell = -\frac{1}{4\mu_0} F_{\mu\nu} F^{\mu\nu} - J^\mu A_\mu$

(D) $\ell = -\frac{1}{16\pi} F_{\mu\nu} F^{\mu\nu} - J^\mu A_\mu$

85. Considering Lagrangian density for absent sources and present fields, the Euler equation leads the expression :

(A) $\partial_\nu F^{\mu\nu} = 0$

(B) $\partial_\nu F^{\mu\nu} = \mu_0 J^\mu$

(C) $\partial_\nu F^{\mu\nu} = -\mu_0 J^\mu$

(D) $\partial_\nu F^{\mu\nu} = \pm \mu_0 J^\mu$

86. If both sources and fields are present then the lagrangian density in CGS system is given by ($F_{\mu\nu}$ - em field tensor :

(A) $\ell = -\frac{1}{4\mu_0} F_{\mu\nu} F^{\mu\nu} + J^\mu A_\mu$

(B) $\ell = +\frac{1}{4\mu_0} F_{\mu\nu} F^{\mu\nu} - J^\mu A_\mu$

(C) $\ell = -\frac{1}{16\pi} F_{\mu\nu} F^{\mu\nu} - J^\mu A_\mu$

(D) $\ell = +\frac{1}{16\pi} F_{\mu\nu} F^{\mu\nu} - J^\mu A_\mu$

87. Considering lagrangian density for present sources and fields, the Euler equation provides :

(A) $\partial_\nu F^{\mu\nu} = \mu_0 J^\mu$

(B) $\partial_\nu F^{\mu\nu} = -\mu_0 J^\mu$

(C) $\partial_\nu F^{\mu\nu} = \pm \mu_0 J^\mu$

(D) None of the above

88. Force density vector is :

(A) A tensor of rank one

(B) Equal to product of em field tensor and velocity tensor

(C) Invariant under Lorentz transformation.

(D) All of the above

89. The time component of force density vector provides :

(A) Power density

(B) Energy density

(C) Charge density

(D) Current density

90. Which can be derived with Euler equation $\partial_v F^{\mu v} = \mu_0 J^{\mu}$?

(A) Equation of continuity

(B) All four Maxwell equations

(C) Maxwell's em wave equation

(D) Lorentz gauge condition

91. Proca lagrangian density for massive vector field without source in MKS system is :

(A) $\ell = -\frac{1}{4\mu_0} F_{\mu v} F^{\mu v} + \frac{m^2}{2\mu_0} A_{\mu} A^{\mu}$

(B) $\ell = -\frac{1}{16\pi} F_{\mu v} F^{\mu v} + \frac{m^2}{8\pi} A_{\mu} A^{\mu}$

(C) $\ell = -\frac{4}{4\mu_0} F_{\mu v} F^{\mu v} + \frac{m^2}{2\mu_0} A_{\mu} A^{\mu} - \mu_0 J^{\mu}$

(D) $\ell = -\frac{1}{16\pi} F_{\mu v} F^{\mu v} + \frac{m^2}{8\pi} A_{\mu} A^{\mu} - \mu_0 J^{\mu}$

92. Proca equation for Massive of vector field having source is given by :

(A) $\left(\square + m^2\right) A^{\mu} = \mu_0 J^{\mu}$

(B) $\left(\square - m^2\right) A^{\mu} = -\mu_0 J^{\mu}$

(C) $\left(\square + m^2\right) A^{\mu} = 0$

(D) $\left(\nabla^2 - m^2\right) A^{\mu} = -\mu_0 J^{\mu}$

93. If rapidity is φ then true relation is :

(A) $\beta = \tanh \varphi$

(B) $\gamma = \cosh \varphi$

(C) $\gamma\beta = \sinh \varphi$

(D) All of the above

94. Which relation is true Lorentz transformation matrix?

(A) $\Lambda^T g \Lambda = g$

(B) $\det\left(\Lambda\right) = \pm 1$

(C) $\Lambda_0^0 \geq 1$

(D) All of the above

95. The value of $(\Lambda_1\Lambda_2)^T g(\Lambda_1\Lambda_2)$ is equal to :

(A) g (metric tensor)

(B) I (Identity matrix)

(C) $\Lambda_1\Lambda_2$

(D) $\Lambda_1 g \Lambda_2$

96. Which statement is correct about phase velocity in Minkowski space?

(A) It can exceed c without violating relativity

(B) It is always less than c

(C) It is identical to group velocity

(D) It has no physical meaning

97. The inverse of Lorentz transformation matrix Λ^{-1} is equal to (g: metric tensor) :

(A) Λ^T

(B) $g^2\Lambda^T$

(C) $g\Lambda^T g$

(D) All of the above

98. Covarient generalization of Hamiltonian density is called as:

(A) EM field tensor

(B) Maxwell stress tensor

(C) Canonical stress tensor

(D) Hamiltonian tensor

99. If F_μ and u_μ are four force and four velocity tensor then the value of $F^\mu u_\mu$ is equal to :

(A) 0

(B) 1

(C) $\beta\gamma$

(D) $\gamma\left(\vec{F}\cdot\vec{u}\right)/c$

100. The correct statement for the nature of velocity associated with events in time-like, space-like, and lightlike intervals in Minkowski spacetime is :

(A) For time like, $v < c$

(B) For space like, $v > c$

(C) For light like, $v = c$

(D) All of the above

Rough Work

Rough Work

Example :

Question :

Q.1 Ⓐ ● Ⓒ Ⓓ

Q.2 Ⓐ Ⓑ ● Ⓓ

Q.3 Ⓐ ● Ⓒ Ⓓ

5. Each question carries equal marks. Marks will be awarded according to the number of correct answers you have.

6. All answers are to be given on OMR Answer Sheet only. Answers given anywhere other than the place specified in the answer sheet will not be considered valid.

7. Before writing anything on the OMR Answer Sheet, all the instructions given in it should be read carefully.

8. After the completion of the examination, candidates should leave the examination hall only after providing their OMR Answer Sheet to the invigilator. Candidate can carry their Question Booklet.

9. There will be no negative marking.

10. Rough work, if any, should be done on the blank pages provided for the purpose in the booklet.

11. To bring and use of log-book, calculator, pager & cellular phone in examination hall is prohibited.

12. In case of any difference found in English and Hindi version of the question, the English version of the question will be held authentic.

Impt. On opening the question booklet, first check that all the pages of the question booklet are printed properly. If there is any discrepancy in the question Booklet, then after showing it to the invigilator, get another question Booklet of the same series.

उदाहरण :

प्रश्न :

प्रश्न 1 Ⓐ ● Ⓒ Ⓓ

प्रश्न 2 Ⓐ Ⓑ ● Ⓓ

प्रश्न 3 Ⓐ ● Ⓒ Ⓓ

5. प्रत्येक प्रश्न के अंक समान हैं। आपके जितने उत्तर सही होंगे, उन्हीं के अनुसार अंक प्रदान किये जायेंगे।

6. सभी उत्तर केवल ओ०एम०आर० उत्तर-पत्रक (OMR Answer Sheet) पर ही दिये जाने हैं। उत्तर-पत्रक में निर्धारित स्थान के अलावा अन्यत्र कहीं पर दिया गया उत्तर मान्य नहीं होगा।

7. ओ०एम०आर० उत्तर-पत्रक (OMR Answer Sheet) पर कुछ भी लिखने से पूर्व उसमें दिये गये सभी अनुदेशों को सावधानीपूर्वक पढ़ लिया जाये।

8. परीक्षा समाप्ति के उपरान्त परीक्षार्थी कक्ष निरीक्षक को अपनी OMR Answer Sheet उपलब्ध कराने के बाद ही परीक्षा कक्ष से प्रस्थान करें। परीक्षार्थी अपने साथ प्रश्न-पुस्तिका ले जा सकते हैं।

9. निगेटिव मार्किंग नहीं है।

10. कोई भी रफ कार्य, प्रश्न-पुस्तिका में, रफ-कार्य के लिए दिए खाली पेज पर ही किया जाना चाहिए।

11. परीक्षा-कक्ष में लॉग-बुक, कैल्कुलेटर, पेजर तथा सेल्युलर फोन ले जाना तथा उसका उपयोग करना वर्जित है।

12. प्रश्न के हिन्दी एवं अंग्रेजी रूपान्तरण में भिन्नता होने की दशा में प्रश्न का अंग्रेजी रूपान्तरण ही मान्य होगा।

महत्वपूर्णः प्रश्नपुस्तिका खोलने पर प्रथमतः जाँच कर देख लें कि प्रश्नपुस्तिका के सभी पृष्ठ भलीभाँति छपे हुए हैं। यदि प्रश्नपुस्तिका में कोई कमी हो, तो कक्षनिरीक्षक को दिखाकर उसी सिरीज की दूसरी प्रश्नपुस्तिका प्राप्त कर लें।