Class Test

(Relativistic Electrodynamics and Relativistic Quantum Mechanics)

Q1. Which of the following questions is not Lorentz invariant?

(a) $|\vec{E}\times\vec{B}|^2$ $\vec{E}$ is electric field vector and $\vec{B}$ magnetic field vector

(b) $|\vec{E}|^2 - |\vec{B}|^2$ $\vec{E}$ is electric field vector and $\vec{B}$ magnetic field vector

(c) $\vec{E}.\vec{B}$ $\vec{E}$ is electric field vector and $\vec{B}$ magnetic field vector

(d) $|\vec{J}|^2 - c^2|\rho|^2$ where $\vec{J}$ is current density and ρ is charge density

Q2. The value of the electric and magnetic fields in a particular reference frame (in Gaussian units) are $E = 3\hat{x} + 4\hat{y}$ and $B = 3\hat{z}$ respectively. An inertial observer moving with respect to this frame measures the magnitude of the electric field to be $|E'| = 5$. The magnitude of the magnetic field $|B'|$ measured by him is

(a) 5 (b) 9 (c) 0 (d) 3

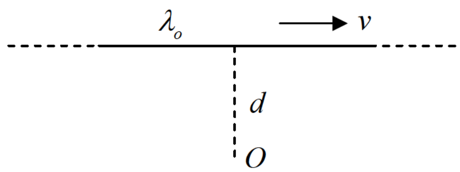
Q3. In an inertial frame S, the magnetic vector potential in a region of space is given by $\vec{A} = az\hat{i}$ (where a is a constant) and the scalar potential is zero. The electric and magnetic fields seen by an inertial observer moving with a velocity $v\hat{i}$ with respect to S, are, respectively [In the following $\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$]

(a) 0 and $\gamma a\hat{j}$ (b) $-va\hat{k}$ and $\gamma a\hat{i}$ (c) $v\gamma a\hat{k}$ and $v\gamma a\hat{j}$ (d) $v\gamma a\hat{k}$ and $\gamma a\hat{j}$

Q4. A rod has charge density λ_0 (seen by observer which is at rest with respect to the observer) and is moving with speed $\frac{c}{2}$ with respect to frame A. Frames A is moving with respect to frame B with speed $\frac{c}{4}$. The Frames A and B are moving in the same direction along the length of the rod. If observer is attached to frame B then the charge density measured by observer is

(a) λ_0 (b) $\frac{3\lambda_0}{\sqrt{5}}$ (d) $\frac{\sqrt{21}\lambda_0}{5}$ (c) $\frac{2\lambda_0}{\sqrt{3}}$

Q5. Infinite long wire of charge density λ_0 move with speed $v\left(\frac{v}{c}\neq 0\right)$ with respect to point "O" which is distance d from wire as shown in figure. Find the electric current in wire with respect point "O".



(a) 0 (b) $v\lambda_0$ (c) $v\lambda_0\sqrt{1-\frac{v^2}{c^2}}$ (d) $\frac{v\lambda_0}{\sqrt{1-\frac{v^2}{c^2}}}$

Q6. Which of the following is Lorentz invariant?

(a) $\frac{1}{c^2}\frac{\partial^2}{\partial t^2}$

(b) Laplacian operator ∇^2

(d) Operator $\square^2=\frac{1}{c^2}\frac{\partial^2}{\partial t^2}-\nabla^2$

(d) operator $\square^2=\frac{1}{c^2}\frac{\partial^2}{\partial t^2}+\nabla^2$

Q7. If ψ is wave function satisfy the klein Gordon equation then which of the following is correct expression of probability density .

(a) $\rho=\frac{i\hbar}{2m_0c^2}\left(\psi^*\frac{\partial\psi}{\partial x}-\psi\frac{\partial\psi^*}{\partial x}\right)$

(b) $\rho=\frac{i\hbar}{2m_0c^2}\left(\psi^*\frac{\partial\psi}{\partial x}+\psi\frac{\partial\psi^*}{\partial x}\right)$

(c) $\rho=\frac{i\hbar}{2m_0c^2}\left(\psi^*\frac{\partial\psi}{\partial t}-\psi\frac{\partial\psi^*}{\partial t}\right)$

(d) $\rho=\frac{i\hbar}{2m_0c^2}\left(\psi^*\frac{\partial\psi}{\partial t}+\psi\frac{\partial\psi^*}{\partial t}\right)$

Q8. Dirac equation for free particle is given by $H=c\vec{\alpha}.\vec{p}+\beta mc^2$ if $\vec{\alpha}=\alpha_x\hat{i}+\alpha_y\hat{j}+\alpha_z\hat{k}$ then which of following is not correct

(a) $\alpha_x\alpha_y+\alpha_y\alpha_x=0$

(b) $\alpha_x\alpha_y-\alpha_y\alpha_x=0$

(c) $\alpha_x\beta+\beta\alpha_x=0$

(d) $|\alpha_x|^2=1$

Q9. The classical Hamiltonian is given by $H=\left[\pi^2c^2+m^2c^4\right]^{1/2}$ the $\psi(t)=|\psi\rangle\exp\left(-\frac{iEt}{\hbar}\right)$ is the solution of Dirac equation with $|\psi\rangle=\begin{bmatrix}\chi\\ \phi\end{bmatrix}$ is two component spinor then which of the following is correct

(a) $\left(E-mc^2\right)\chi-c\vec{\sigma}.\vec{\pi}\phi=0$ and $\left(E-mc^2\right)\phi-c\vec{\sigma}.\vec{\pi}\chi=0$

(b) $\left(E-mc^2\right)\chi-c\vec{\sigma}.\vec{\pi}\phi=0$ and $\left(E+mc^2\right)\phi-c\vec{\sigma}.\vec{\pi}\chi=0$

(c) $\left(E+mc^2\right)\chi-c\vec{\sigma}.\vec{\pi}\phi=0$ and $\left(E+mc^2\right)\phi-c\vec{\sigma}.\vec{\pi}\chi=0$

(d) $\left(E+mc^2\right)\chi-c\vec{\sigma}.\vec{\pi}\phi=0$ and $\left(E-mc^2\right)\phi-c\vec{\sigma}.\vec{\pi}\chi=0$

Q10. A charge q is interact with magnetic field $\vec{B}$ with associate vector potential $\vec{A}$. Operator $\vec{\pi}$ is defined as $\vec{\pi} = \vec{p} - \frac{q\vec{A}}{c}$, then value of $\vec{\pi} \times \vec{\pi}$ is

(a) 0 (b) $-\frac{i\hbar q}{c}\vec{B}$ (c) $\frac{i\hbar q}{2c}\vec{B}$ (d) $\frac{i\hbar q}{c}\vec{B}$