

This is a closed book quiz! Write the best choice in the space next to the question.

_____ 1. Given a coordinate transformation matrix a_{ij} and a tensor \mathbf{T} , which of the following is the correct expression for T'_{ij} , the tensor elements expressed in the transformed coordinate system?

- A. $T'_{ij} = \sum_k a_{ij} T_{kk}$
- B. $T'_{ij} = \sum_{kl} a_{ij} T_{kl}$
- C. $T'_{ij} = \sum_{kl} a_{kl} T_{ij}$
- D. $T'_{ij} = \sum_{kl} a_{ik} a_{jl} T_{kl}$
- E. $T'_{ij} = \sum_{kl} a_{ik} T_{kl} a_{lj}$

_____ 2. As shown in class, the electric field from a static charge distribution $\rho(\mathbf{r})$ is

$$\mathbf{E}(\mathbf{r}) = \int_{\text{all space}} \frac{\rho(\mathbf{r}')(\mathbf{r} - \mathbf{r}')}{|\mathbf{r} - \mathbf{r}'|^3} dV'$$

Which of the following is true for all static electric fields, where $Q = \int \rho(\mathbf{r}) dV$:

I. $\nabla \cdot \mathbf{E} = 4\pi\rho$ II. $\nabla \times \mathbf{E} = 0$ III. $|\mathbf{E}| = Q/|\mathbf{r}|^2$

- A. I only
- B. II only
- C. III only
- D. I and II only
- E. I and III only

_____ 3. The electric potential is evaluated at a certain point *far* from a localized charge distribution *whose net charge is zero*. At a point twice as far away, but in the same direction, the electric potential is

- A. multiplied by 2.
- B. multiplied by 1/2.
- C. multiplied by 1/4.
- D. multiplied by 1/8.
- E. the same, since it must equal zero everywhere.

Name: _____

PHYS4210

Electromagnetic Theory

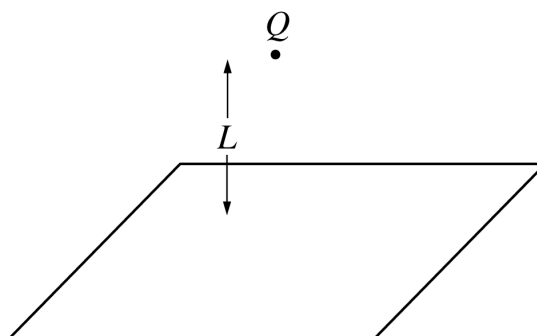
Quiz 2 Feb 2009

This is a closed book quiz! Write the best choice in the space next to the question.

_____ 1. Five positive charges of magnitude q are arranged symmetrically around the circumference of a circle of radius r . What is the magnitude of the electric field at the center of the circle?

- A. 0
- B. q/r^2
- C. $5q/r^2$
- D. $q/r^2 \cos(2\pi/5)$
- E. $5q/r^2 \cos(2\pi/5)$

_____ 2. A positive charge Q is located at a distance L above an infinite grounded conducting plane:



What is the total charge induced on the plane?

- A. $2Q$
- B. Q
- C. 0
- D. $-Q$
- E. $-2Q$

_____ 3. An infinitely long wire is charged by an amount λ per unit length. The electric field magnitude at a distance r from the wire is

- A. 0
- B. λ/r
- C. $\lambda/2\pi r$
- D. λ/r^2
- E. $\lambda/4\pi r^2$

Name: _____

PHYS4210

Electromagnetic Theory

Quiz 17 Feb 2009

This is a closed book quiz! Write the best choice in the space next to the question.

- _____ 1. An azimuthally symmetric, localized charge distribution has no net charge, zero dipole moment, but a nonzero quadrupole moment. At a large distance r from the distribution, the electric potential $\phi(r, \theta)$ falls like
- A. $1/r$
 - B. $1/r^2$
 - C. $1/r^3$
 - D. $1/r^4$
 - E. $1/r^8$
- _____ 2. A spherical conducting shell of inner radius a and outer radius b carries a net charge Q . The electric potential as a function of the radius r , for $a \leq r \leq b$ is
- A. 0
 - B. Q/a
 - C. Q/b
 - D. Q/r
 - E. Q/r^2
- _____ 3. Two events are separated in space by a distance Δx and in time by an interval Δt . Which of the following quantities must have the same value if the events are viewed by an observer in a different reference frame, moving at a speed v relative to the first? We write $\beta \equiv v/c$ and $\gamma = 1/\sqrt{1 - \beta^2}$.
- A. $\Delta x/\gamma$
 - B. $\gamma\Delta t$
 - C. $(\Delta x/\gamma)^2 - (\gamma c\Delta t)^2$
 - D. $(c\Delta t)^2 - (\Delta x)^2$
 - E. $(c\Delta t)^2 + (\Delta x)^2$

Name: _____

PHYS4210

Electromagnetic Theory

Quiz 23 Feb 2009

This is a closed book quiz! Write the best choice in the space next to the question.

- _____ 1. The electric field \mathbf{E} from an isolated point charge $q > 0$
- A. points radially outward and falls like $1/r$.
 - B. points radially outward and falls like $1/r^2$.
 - C. points radially inward and falls like $1/r$.
 - D. points radially inward and falls like $1/r^2$.
 - E. falls like $1/r^{n+1}$ for a multipole of order n .
- _____ 2. A charge q moves at some velocity \mathbf{v} relative to a wire carrying current but no net charge. It feels a force from the current in the wire because
- A. Coulomb's law implies a force field when combined with special relativity.
 - B. magnetism is a fundamental force of nature, and must be postulated.
 - C. the divergence of the magnetic field is zero.
 - D. the curl of the electric field is zero.
 - E. all moving charges experience an electromotive force.
- _____ 3. Which of the following statements is *false*?
- A. The electric field \mathbf{E} is a polar vector in three-dimensional space.
 - B. The magnetic field \mathbf{B} is an axial vector in three-dimensional space.
 - C. The inner product $\mathbf{E} \cdot \mathbf{B}$ of electric and magnetic fields is invariant under *both* spatial rotations and Lorentz transformations.
 - D. The electric field \mathbf{E} and magnetic field \mathbf{B} are three-vector components of Lorentz transformation four-vectors.
 - E. The electric field \mathbf{E} and magnetic field \mathbf{B} are all that we need to specify the electromagnetic field tensor $F^{\mu\nu}$ in any particular reference frame.

Name: _____

PHYS4210

Electromagnetic Theory

Quiz 2 March 2009

This is a closed book quiz! Write the best choice in the space next to the question.

_____ 1. Maxwell's equations can be written in the form shown below. If magnetic charge exists and if it is conserved, which of these equations will have to be changed?

I: $\nabla \cdot \mathbf{E} = 4\pi\rho$

II: $\nabla \cdot \mathbf{B} = 0$

III: $\nabla \times \mathbf{E} = -(1/c)\partial\mathbf{B}/\partial t$

IV: $\nabla \times \mathbf{B} = (1/c)\partial\mathbf{E}/\partial t + 4\pi\mathbf{j}$

- A. I only.
- B. II only.
- C. III only.
- D. I and IV.
- E. II and III.

_____ 2. An infinitely long wire carries a steady current. The magnetic field varies with distance r from the wire as

- A. $1/r$
- B. $\ln r$
- C. a constant.
- D. r
- E. r^2

_____ 3. An infinitely long wire carries a constant linear charge density. The electric field varies with distance r from the wire as

- A. $1/r$
- B. $\ln r$
- C. a constant.
- D. r
- E. r^2

Name: _____

PHYS4210

Electromagnetic Theory

Quiz 6 April 2009

This is a closed book quiz! Write the best choice in the space next to the question.

_____ 1. A wave component moving in the z -direction is written as the complex function

$$E(z, t) = E_0 e^{-i(kz - \omega t)}$$

Which of the following represents the *physical* wave corresponding to this function?

- A. $E_0 \sin(kz - \omega t)$
- B. $E_0 \cos(kz - \omega t)$
- C. $E_0 \sin[i(kz - \omega t)]$
- D. $E_0 \cos[i(kz - \omega t)]$
- E. $E_0 \cos(kz - \omega t) + E_0 \sin(kz - \omega t)$

_____ 2. The “wavelength” of an transverse, traveling electromagnetic plane wave is the smallest spatial distance between two maxima of the electric field. For a wave having (angular) frequency ω in a medium with (real) index of refraction n , the wavelength is

- A. $2\pi c/\omega$
- B. $2\pi n c/\omega$
- C. $2\pi c/n\omega$
- D. $2\pi(n - 1)c/\omega$
- E. $2\pi c/(n - 1)\omega$

_____ 3. A plane wave is incident on a plane boundary between two dielectric media with different indices of refraction. What boundary conditions are imposed so that the reflected and transmitted waves can be uniquely determined?

- I: Continuous parallel electric fields
- II: Continuous perpendicular electric fields
- III: Continuous parallel magnetic fields
- IV: Continuous perpendicular magnetic fields

- A. I only
- B. III only
- C. I and II only
- D. III and IV only
- E. I and III only

Name: _____

PHYS4210

Electromagnetic Theory

Quiz 13 April 2009

This is a closed book quiz! Write the best choice in the space next to the question.

_____ 1. An oscillating *electric quadrupole* emits electromagnetic radiation. If r represents the distance from the source, then the magnetic field at large distances falls like

- A. $1/\sqrt{r}$
- B. $1/r$
- C. $1/r^{3/2}$
- D. $1/r^2$
- E. $1/r^3$

_____ 2. Which of the following is *not* one of Maxwell's Equations?

- A. $\nabla \cdot \mathbf{E} = 4\pi\rho$
- B. $\nabla \cdot \mathbf{B} = 0$
- C. $\nabla \times \mathbf{E} = -(1/c)\partial\mathbf{B}/\partial t$
- D. $\nabla \times \mathbf{B} = (1/c)\partial\mathbf{E}/\partial t + 4\pi\mathbf{j}$
- E. $\mathbf{F} = q\mathbf{E} + (q/c)\mathbf{v} \times \mathbf{B}$

_____ 3. A beam of light passes from the air into a pool of still water, making a 45° angle with the vertical. Assuming that the index of refraction of water is given by

$$n = \sqrt{1 + \frac{4\pi e^2 N}{m(\omega_0^2 - \omega^2)}}$$

as we derived in class, which of the following correctly orders the angle which the light beam in the water makes with the vertical?

- A. red>yellow>blue
- B. blue>yellow>red
- C. red>blue>yellow
- D. yellow>blue>red
- E. red=yellow=blue