

Level : B.Sc.
Year : I

Course : PHYS 102
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 15

Registration No.:

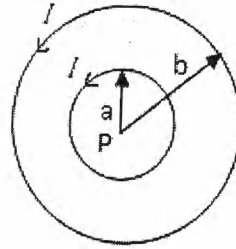
Date : JUL 09 2017

SECTION "A"
[15Q × 1 = 15 marks]

Choose and tick the most appropriate answer.

- Which one of the following statements is NOT CORRECT?
[a] the divergence of gradient is a scalar.
[b] the gradient of divergence is a vector.
[c] the Laplacian of a vector is a scalar.
[d] the curl of curl is a vector.
- The Laplacian of the function $T = x(x + 2y) + 3z + 4$ is
[a] $2(2x + y) + 3$. [b] 2. [c] $2\hat{i}$. [d] $2(x + y)\hat{i} + 2x\hat{j} + 3\hat{k}$.
- When a cube is inscribed in a sphere of radius r , the length L of a side of the cube is $L = \sqrt{\frac{4}{3}} r$.
If a positive point charge Q is placed at the center of the spherical surface, the ratio of the electric flux Φ_{sphere} at the spherical surface to the flux Φ_{cube} at the surface of the cube is
[a] 1. [b] $\sqrt{\frac{4}{3}}$. [c] $\frac{4}{3}$. [d] $\sqrt{\frac{3}{4}}$.
- When a perfectly conducting sphere is placed in a uniform external electric field \vec{E}_0 , then
[a] electric potential is zero everywhere inside the sphere.
[b] electric field is non-zero constant everywhere inside the sphere.
[c] electric potential is non-zero constant everywhere inside the sphere.
[d] electric field at the centre is zero and increases as we move toward the surface.
- The electrostatic potential energy of configuration of three charges $+2e, -e$ and $-2e$ placed at three corners A, B and C of an equilateral triangle of side ' l ' is
[a] $-\frac{e^2}{\pi\epsilon_0 l}$. [b] $\frac{e^2}{\pi\epsilon_0 l}$. [c] $-\frac{e^2}{4\pi\epsilon_0 l}$. [d] $-\frac{e^2}{\pi\epsilon_0 l^2}$.
- The unit of the atomic polarizability is
[a] Farad per meter squared. [b] Farad per meter.
[c] Farad meter. [d] Farad meter squared.
- The electric susceptibility (χ) in term of bound charge density (ρ_b) and free charge density (ρ_f) is
[a] $-\frac{\rho_f}{\rho_f + \rho_b}$. [b] $-\frac{\rho_b}{\rho_f + \rho_b}$. [c] $-\frac{\rho_f + \rho_b}{\rho_f}$. [d] $-\frac{\rho_f + \rho_b}{\rho_b}$.

8. Suppose that the magnetic field points in the x-direction and the electric field in the z-direction. A charged particle is released from the origin. The path followed by the particle is
 [a] a circle on yz-plane. [b] a cycloid on yz-plane.
 [c] a cycloid on xz-plane. [d] a cycloid on xy-plane.
9. What is the magnitude of the magnetic field at point P if $a = R$ and $b = 2R$?



- [a] $\frac{3\mu_0 I}{4R}$ [b] $\frac{\mu_0 I}{4R}$ [c] $\frac{2\mu_0 I}{4R}$ [d] $\frac{3\mu_0 I}{4\pi R}$
10. The area of M-H hysteresis loop is an indication of the
 [a] retentivity of the materials.
 [b] permeability of material.
 [c] energy dissipated per unit volume of the substance per cycle.
 [d] susceptibility of materials.
11. The magnetic field strength \vec{H} within a solenoid with n turns per unit length (length = ℓ) and current I has magnitude H equal to
 [a] nI . [b] $\mu_0 nI$. [c] $(1 + \mu_0)nI$. [d] $\frac{\mu_0 nI}{\ell}$
12. The mutual inductance between two loops is independent of
 [a] shape of the loops. [b] size of the loops.
 [c] relative distance between the loops. [d] currents along the loops.
13. The speed of electromagnetic waves in vacuum is equal to
 [a] $\epsilon_0 \mu_0$. [b] $\sqrt{\epsilon_0 \mu_0}$. [c] $\frac{1}{\sqrt{\epsilon_0 \mu_0}}$. [d] $\frac{1}{\epsilon_0 \mu_0}$.
14. One form of fusion reaction occurring on the Sun is
 [a] the fusion of one hydrogen nucleus with a neutron to form a helium nucleus.
 [b] the fusion of two helium nuclei to form a hydrogen nucleus.
 [c] the fusion of two neutrons to form a helium nucleus.
 [d] the fusion of two hydrogen nuclei to form a helium nucleus.
15. Find the unknown atomic number and mass number respectively, for the following reaction

$$n + {}_{92}^{235}\text{U} \rightarrow \frac{A}{Z}\text{X} + {}_{38}^{94}\text{Sr} + 2n$$

 [a] 141, 53 [b] 140, 54 [c] 53, 41 [d] 54, 140

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SECTION "B"
[5Q × 3 = 15 marks]

Attempt *ALL* questions.

1. Derive the **Clausius-Mossotti** formula for non-polar dielectrics.
2. Show that $\vec{F} = yz\hat{i} + zx\hat{j} + xy\hat{k}$ can be written both as the gradient of a scalar and as the curl of a vector.

OR

A uniformly charged solid sphere of radius R has a uniform volume charge density ρ and carries a total positive charge q . Find the magnitude of the electric field at a point inside the sphere.

3. Derive an expression for the torque on a rectangular coil of area A , carrying a current I and placed in a uniform magnetic field B . The angle between the direction of B and the vector perpendicular to the plane of the coil is θ . Under what circumstances; will a current carrying loop not rotate in the magnetic field?

OR

Show that when a magnetic field is applied on a diamagnetic substance, the change in the dipole moment of an orbiting electron is given by $\Delta\vec{m} = -\frac{e^2 r^2}{4m_e} \vec{B}$, where the symbols have their usual meanings.

4. What is motional emf? Obtain the flux rule for motional emf.
5. Find the potential inside a spherical shell of radius R (Figure B-1), which carries a uniform surface charge σ .

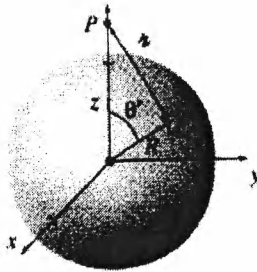


Figure B-1
OR

How long does it take for 60% of a sample of radon to decay? Half-life of radon is 3.8 days.

SECTION "C"
[5Q × 5 = 25 marks]

Attempt *ALL* questions.

6. A (physical) **electric dipole** consists of two equal and opposite charges ($\pm q$) separated by a distance d . Find the approximate potential at points far from the dipole and show that the electric field of a dipole in the coordinate-free form is given by

$$\vec{E}_{\text{dip}}(\vec{r}) = \frac{1}{4\pi\epsilon_0} \frac{1}{r^3} [3(\vec{p} \cdot \hat{r}) \hat{r} - \vec{p}].$$

7. Define divergence of a vector. Derive an expression for the divergence of a vector field in Cartesian co-ordinates.

OR

Derive an expression for work done to assemble the N number of point charges by bringing them from infinity. Update your result for a system of continuous charge and hence obtain the electrostatic energy density.

8. Explain how Maxwell fixed up Ampere's law. Derive the wave equation for \vec{E} and \vec{B} for electromagnetic waves in vacuum.

OR

State and prove "work-energy theorem" of electrodynamics.

9. What do you understand by superconductivity? Give the electrical and magnetic properties of a superconductor. A superconducting tin has a critical temperature of 3.7 K in zero magnetic field and a critical field of 0.0306 T at 0 K. Find the critical field at 2 K.

10. Find the magnetic vector potential of a finite segment of a straight wire carrying a current I . Also calculate the magnetic field associated with this potential.

OR

Find the magnetic field on the axis of a tightly wound solenoid (helical coil) consisting of n turns per unit length wrapped around a cylindrical tube of radius a and carrying current I (Figure C-1) Express your answer in terms of θ_1 and θ_2 . Consider the turns to be essentially circular. What is the field on the axis of an infinite solenoid (infinite in both directions)?

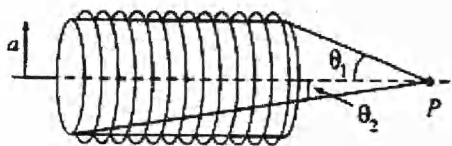


Figure C-1