Dr. Shyama Prasad Mukherjee University

University Department of Physics

Model question

Electronics Sem-V

Paper-CC-12

GROUP-A(MCQ)

Answer all questions 15X2=30

1. Gradient of a function is a constant. State True/False.
a) True
b) False

Answer: b
Explanation: Gradient of any scalar function may be defined as a vector. The vector's magnitude and direction are those of the maximum space rate of change of φ.

2. The mathematical perception of the gradient is said to be
a) Tangent
b) Chord
c) Slope
d) Arc

Answer: c
Explanation: The gradient is the rate of change of space of flux in electromagnetics. This is analogous to the slope in mathematics.

3. Divergence of gradient of a vector function is equivalent to
a) Laplacian operation
b) Curl operation
c) Double gradient operation
d) Null vector

Answer: a
Explanation: Div (Grad V) = $(Del)^2V$, which is the Laplacian operation. A function is said to be harmonic in nature, when its Laplacian tends to zero.

4. The gradient of xi + yj + zk is
a) 0
b) 1
c) 2
d) 3

Answer: d
Explanation: Grad (xi + yj + zk) = 1 + 1 + 1 = 3. In other words, the gradient of any position vector is 3.

This set of Electromagnetic Theory Multiple Choice Questions & Answers (MCQs) focuses on "Divergence".

5. The divergence of a vector is a scalar. State True/False.
a) True
b) False

Answer: a
Explanation: Divergence can be computed only for a vector. Since it is the measure of outward flow of flux from a small closed surface as the volume shrinks to zero, the result will be directionless (scalar).

6. The divergence concept can be illustrated using Pascal's law. State True/False.
a) True
b) False

Answer: a
Explanation: Consider the illustration of Pascal's law, wherein a ball is pricked with holes all over its body. After water is filled in it and pressure is applied on it, the water flows out the holes uniformly. This is analogous to the flux flowing outside a closed surface as the volume reduces.

7. Compute the divergence of the vector xi + yj + zk.
a) 0
b) 1
c) 2
d) 3

Answer: d
Explanation: The vector given is a position vector. The divergence of any position vector is always 3.

8. Find the divergence of the vector yi + zj + xk.
a) -1
b) 0
c) 1
d) 3

Answer: b
Explanation: Div (yi + zj + xk) = Dx(y) + Dy(z) + Dz(x), which is zero. Here D refers to partial differentiation.

9. Coulomb is the unit of which quantity?
a) Field strength
b) Charge
c) Permittivity
d) Force

Answer: b
Explanation: The standard unit of charge is Coulomb. One coulomb is defined as the 1 Newton of force applied on 1 unit of electric field.

10. Coulomb law is employed in
a) Electrostatics
b) Magnetostatics
c) Electromagnetics

d) Maxwell theory

Answer: a
Explanation: Coulomb law is applied to static charges. It states that force between any two point charges is proportional to the product of the charges and inversely proportional to square of the distance between them. Thus, it is employed in electrostatics.

11. Find the force between 2C and -1C separated by a distance 1m in air (in newton).
a) 18×10^{6}
b) -18×10^{6}
c) 18×10^{-6}
d) -18×10^{-6}

Answer: b
Explanation: $F = q1q2/(4\prod\varepsilon or^{2}) = -2 \times 9/(10^{-9} \times 12) = -18 \times 10^{9}$.

12. Two charges 1C and -4C exists in air. What is the direction of force?
a) Away from 1C
b) Away from -4C
c) From 1C to -4C
d) From -4C to 1C

Answer: c
Explanation: Since the charges are unlike, the force will be attractive. Thus, the force directs from 1C to -4C.

13. Find the force of interaction between 60 stat coulombs and 37.5 stat coulomb spaced 7.5cm apart in transformer oil($\varepsilon r=2.2$) in 10^{-4} N,
a) 8.15
b) 5.18
c) 1.518
d) 1.815

Answer: d
Explanation: 1 stat coulomb = $1/(3 \times 10^{9})$ C
$F = (1.998 \times 1.2488 \times 10^{-16})/(4\prod \times 8.854 \times 10^{-12} \times 2.2 \times (7.5 \times 10^{-2})^{2}) = 1.815 \times 10^{-4}$ N.

14. The electric field intensity is defined as
a) Force per unit charge
b) Force on a test charge
c) Force per unit charge on a test charge
d) Product of force and charge

Answer: c
Explanation: The electric field intensity is the force per unit charge on a test charge, i.e, q1 = 1C. $E = F/Q = Q/(4\prod\varepsilon r2)$.

15. Find the force on a charge 2C in a field 1V/m.
a) 0
b) 1
c) 2
d) 3

Answer: c
Explanation: Force is the product of charge and electric field.
F = q X E = 2 X 1 = 2 N.

16. Find the electric field intensity of two charges 2C and -1C separated by a distance 1m in air.
a) 18 X 10^9
b) 9 X 10^9
c) 36 X 10^9
d) -18 X 10^9

Answer: b
Explanation: F = q1q2/(4∏εor2) = -2 X 9/(10^{-9} X 12) = -18 X 10^9
E = F/q = 18 X 10^9/2 = 9 X 10^9.

17. What is the electric field intensity at a distance of 20cm from a charge 2 X 10^{-6} C in vacuum?
a) 250,000
b) 350,000
c) 450,000
d) 550,000

Answer: c
Explanation: E = Q/ (4∏εor2)
= (2 X 10^{-6})/(4∏ X εo X 0.2^2) = 450,000 V/m.

18. Determine the charge that produces an electric field strength of 40 V/cm at a distance of 30cm in vacuum (in 10^{-8}C)
a) 4
b) 2
c) 8
d) 6

Answer: a
Explanation: E = Q/ (4∏εor^2)
Q = (4000 X 0.3^2)/ (9 X 10^9) = 4 X 10^{-8} C.

19.This set of Electromagnetic Theory Multiple Choice Questions & Answers (MCQs) focuses on “Gauss Law”.

20. Divergence theorem is based on
a) Gauss law
b) Stoke’s law
c) Ampere law
d) Lenz law

Answer: a
Explanation: The divergence theorem relates surface integral and volume integral.
Div(D) = ρv, which is Gauss’s law.

21. The Gaussian surface for a line charge will be
a) Sphere
b) Cylinder
c) Cube

d) Cuboid

Answer: b
Explanation: A line charge can be visualized as a rod of electric charges. The three-dimensional imaginary enclosed surface of a rod can be a cylinder.

22. The Gaussian surface for a point charge will be
a) Cube
b) Cylinder
c) Sphere
d) Cuboid

Answer: c
Explanation: A point charge is single dimensional. The three-dimensional imaginary enclosed surface of a point charge will be sphere.

23. A circular disc of radius 5m with a surface charge density $\rho s = 10\sin\varphi$ is enclosed by surface. What is the net flux crossing the surface?
a) 3
b) 2
c) 1
d) 0

Answer: d
Explanation: $Q = \int \rho s ds = \iint 10\sin\varphi \, r dr d\varphi$, on integrating with r = 0->5 and φ = 0->2π, we get $Q = \psi = 0$.

24. The total charge of a surface with densities 1, 2,…,10 is
a) 11
b) 33
c) 55
d) 77
Answer: c
Explanation: $Q = \iint D.ds$. Since the data is discrete, the total charge will be summation of 1,2,…,10,i.e, 1+2+…+10 = 10(11)/2 = 55.

25. The work done by a charge of 10μC with a potential 4.386 is (in μJ)
a) 32.86
b) 43.86
c) 54.68
d) 65.68

Answer: b
Explanation: By Gauss law principles, $W = Q \times V = 10 \times 10^{-6} \times 4.386 = 43.86 \times 10^{-6}$ joule.

26. The potential of a coaxial cylinder with charge density 1unit, inner radius 1m and outer cylinder 2m is (in 10^9)
a) 12.74
b) 13.47
c) 12.47
d) 13.74

Answer: c
Explanation: The potential of a coaxial cylinder will be ρl ln(b/a)/2πε, where ρl = 1, b = 2m and a = 1m. We get V = 12.47 X 10^9 volts.

27. Gauss law can be used to compute which of the following?
a) Permittivity
b) Permeability
c) Radius of Gaussian surface
d) Electric potential

Answer: c
Explanation: Gauss law relates the electric flux density and the charge density. Thus it can be used to compute radius of the Gaussian surface. Permittivity and permeability are constants for a particular material.

28. Three charged cylindrical sheets are present in three spaces with σ = 5 at R = 2m, σ = -2 at R = 4m and σ = -3 at R = 5m. Find the flux density at R = 1m.
a) 0
b) 1
c) 2
d) 3

Answer: a
Explanation: Since 1m does not enclose any cylinder (three Gaussian surfaces of radius 2m, 4m, 5m exists), the charge density and charge becomes zero according to Gauss law. Thus, flux density is also zero.

29. Three charged cylindrical sheets are present in three spaces with σ = 5 at R = 2m, σ = -2 at R = 4m and σ = -3 at R = 5m. Find the flux density at R = 3m.
a) 3
b) 10/3
c) 11/3
d) 4

Answer: b
Explanation: The radius is 3m, hence it will enclose one Gaussian cylinder of R = 2m.
By Gauss law, ψ = Q
D(2πRL) = σ(2πRL), D(2π X 3) = σ(2π X 2), Thus D = 10/3 units.

30. Three charged cylindrical sheets are present in three spaces with σ = 5 at R = 2m, σ = -2 at R = 4m and σ =-3 at R = 5m. Find the flux density at R = 4.5m.
a) 4/4.5
b) 3/4.5
c) 2/4.5
d) 1/4.5

Answer: c
Explanation: The Gaussian cylinder of R = 4.5m encloses sum of charges of two cylinders (R = 2m and R = 4m).
By Gauss law, ψ = Q
D(2πRL) = σ(2πRL), D(2π X 4.5) = Q1 + Q2 = σ1(2π X 2) + σ2(2π X 4), here σ1 = 5 and σ2 = -2. We get D = 2/4.5 units.

Group-B

Answer any four 4X5=20

1. There are two charges q1 and q2 at position vector r1 and r2. Find the electric field at r.
2. State and prove Gauss theorem.
3. Find an expression for electric potential at any point due to a line charge.
4. Four charges 3μc, -4 μc, 5 μc and -2 μc are situated at points P(4,-3,5); Q(3,2,1); R(2,3,2) and S(1,-7,3) respectively. Find electric potential at point (5,-4,-3).
5. Explain Biot-Savart's law. How can it be used to determine the field due to a long linear conductor?
6. Calculate the flus density at a point on the axis of a circular coil carrying steady current.
7. Discuss the effect of introducing a dielectric between the plates of a capacitor.
8. What do you understand by electric intensity, electric polarisation and electric displacement? Derive a relation between them.

Group-C

Answer any two 2X12.5=20

1. A. what do you understand by the electrostatic interaction? What do you mean by the statement that charge is quantised? State the law of conservation of charge
   B. Derive an expression for the electric field due to a point charge located at
   1. origin
   2. any arbitrary point

2. write notes on the following
   1. equipotential surface
   2. storing of charges by conductor
   3. conductor placed in an electric field

3. Discuss the integral form Maxwell's equations.

4. Discuss the propagation of electromagnetic wave in a medium with $\sigma=0$.
5. Discuss the propagation of electromagnetic wave in a medium with $\sigma\neq0$.