1.Consider the following statements associated with the basic electrostatic properties of ideal conductors :
1) The resultant field inside is zero
2) The net charge density in the interior is zero
3) Any net charges reside on the surface
4) The surface is always equipotential
5) The field just outside is zero
Which of the above statements are correct?

A. 1, 2, 3 and 4
B. 3, 4 and 5 only
C. 1, 2 and 3 only
D. 2 and 3 only

Answer ||| A

Solution ||| The basic electrostatic properties of idela conductors are :
1) The resultant field inside is zero.
2) The net charge density in the interior is zero.
3) Any net charges reside on the surface.
4) The surface is always equipotential.
The field just outside the conductor is not zero.

2.Consider an electric field $\vec{E} = \hat{i}\ Ax$ exist in space, where A = 10V/m^2. Take the potential at (10m, 20m) to be zero. Find the potential at origin.

A. 500V
B. 250V
C. 750V
D. 900V

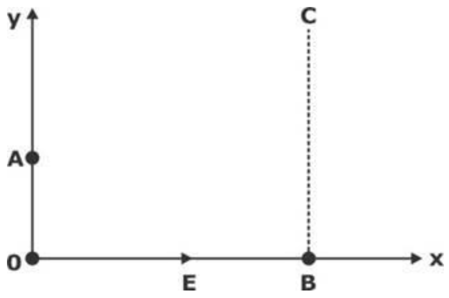
Answer ||| A

Solution |||

Given: V = 0 at (10, 20)

$\vec{E} = \hat{i}\ Ax$

Since the line BC is parallel to y-axis and hence perpendicular to electric field and hence it is an equipotential line.



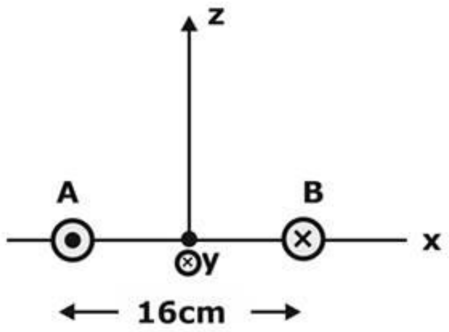
$V_C = V_B = 0$

$$V_A - V_B = \int_A^B E dx = \int_0^{10} (Ax)\, dx$$

$$V_A = 10 \times \left[\frac{x^2}{2}\right]_0^{10}$$

$V_A = 500V$

3.Find the magnitude of force per unit length on conductor A due to conductor B. If each conductor carries a current of 12A in the opposite direction as shown below



A. 0.12 mN/m
B. 0.15 mN/m
C. 0.18 mN/m
D. 0.24 mN/m

Answer ||| C

Solution |||

Magnetic field due to conductor B at point A.

$$\bar{B} = \frac{\mu_0 I}{2\pi\rho}\hat{a}_z$$

$\bar{B}$ in $\hat{z}$ direction

$\bar{\ell}$ in $-\hat{y}$ direction

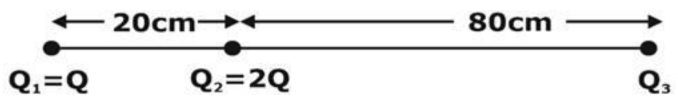
$$\bar{F} = I(\bar{\ell} \times \bar{B})(-\hat{x})$$

$$= -I\left(|\ell||B|\sin 90\right)\hat{x}$$

$$= -12 \times \ell \times \frac{4\pi \times 10^{-7} \times 12}{2\pi \times 16 \times 10^{-2}}\hat{x}$$

$$\frac{F}{\ell} = -1.8 \times 10^{-4}\hat{x} = -0.18\hat{x} \ \text{mN/m}$$

4.A system of three electric charges Q_1, Q_2, Q_3 as shown in figure lying in a straight line is in equilibrium the third change Q_3 is



A. 8Q
B. 16Q
C. 3Q
D. 4Q

Answer ||| B

Solution |||

⇒ System is in equilibrium so net force on Q_2 will be zero –

Force due to Q_1 is in positive X - direction so it will be positive, and due to Q_3 is in the negative X - direction so it will be negative.

⇒ $$F_{Q_2} = \frac{kQ_1Q_2}{(20)^2} - \frac{kQ_2Q_3}{(80)^2}$$

⇒For equilibrium $F_{Q2} = 0$

$$= \frac{Q_1Q_2}{1} - \frac{Q_2Q_3}{16}$$

$Q_2Q_3 = 16Q_1Q_2$

$Q_3 = 16Q_1 = 16Q$

5.Find the relative permittivity of dielectric material used in a parallel plate capacitor if electric flux density D = 15 μ c/m^2 and energy density is 20 J/m^3.

A. 0.63
B. 0.85
C. 0.92
D. 1.1

Answer ||| A

Solution |||

Energy density $W_E = \frac{1}{2}\frac{D^2}{\varepsilon}$

$$20 = \frac{1}{2}\frac{(15\mu)^2}{\varepsilon_0 \varepsilon_r}$$

$$\varepsilon_r = \frac{1 \times 225 \times 10^{-12}}{2 \times \varepsilon_0 \times 20}$$

= 0.63

6.Four charges of 5C, –12C, 16C and –7C are located at (3, 4, 5) m, (4, 5, 6) m, (–3, –2, 5) m and (–5, 3, 5) m respectively. Find the net electric flux leaving a sphere of radius 8m and centered at origin.

A. 9C
B. –3C
C. –14C
D. None of these

Answer ||| D

Solution |||

Given four charges as:

Q_A = 5C at A (3, 4, 5) m

$$r_A = \sqrt{3^2 + 4^2 + 5^2} < 8\,\text{m}$$

$\Rightarrow Q_A$ is inside the sphere

Q_B = –12C at B (4, 5, 6) m

$r_B = \sqrt{4^2 + 5^2 + 6^2} > 8\,m$

$\Rightarrow Q_B$ is outside the sphere

Q_C = 16 C at C (–3, –2, 5) m

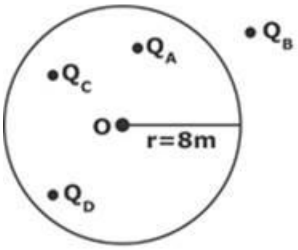
$r_C = \sqrt{(-3)^2 + (-2)^2 + 5^2} < 8\,m$

$\Rightarrow Q_C$ is inside the sphere

Q_D = –7C at D (–5, 3, 5) m

$r_D = \sqrt{(-5)^2 + 3^2 + 5^2} < 8\ m$

$\Rightarrow Q_D$ is inside the sphere



By Gauss's law,

Net flux leaving the sphere = Charge enclosed by the sphere

$\Rightarrow\ \psi = Q_{enclosed}$

$\psi = Q_A + Q_C + Q_D$

= 5C + 16C + (–7C)

= 14 C

7.Match list-I with List-II and select the correct answer.

List-I

A) Gauss law

B) Biot Savarts law

C) Amperes law

D) Magnetic mono poles does not exist

List-II

1) $\bar{B} = \frac{\mu_0 I}{4\pi} \int \frac{\bar{d}\ell \times \bar{R}}{R^2}$

2) $\nabla \cdot D = V_v$

3) $\nabla \cdot B = 0$

4) $\nabla \times B = \mu_0 J$

A. A-1 B-2 C-3 D-4
B. A-2 B-1 C-3 D-4
C. A-3 B-4 C-2 D-1
D. A-2 B-4 C-1 D-3

Answer ||| B

Solution |||

From the definitions of respective laws

$\nabla \cdot D = \rho_v$ Gauss law

$\bar{B} = \frac{\mu_0 I}{4\pi} \int \frac{\overline{d\ell} \times \bar{R}}{R^3}$ – Biot Savart's law

$\nabla \cdot B = 0$ Magnetic mono poles does not exist

$\nabla \times B = \mu_0 J$ Amperes law

∴ Answer is option (B)

8.Depth of penetration δ is equal to $\frac{\lambda}{2\pi}$ for

A. Good insulator
B. Good conductor
C. Lossy medium
D. Low values of λ

Answer ||| B

Solution ||| Skin depth $\delta \propto \frac{1}{\alpha}$ and for good conductor

$\alpha = \beta = \sqrt{\frac{\omega\mu\sigma}{2}}$

Also, $\alpha = \beta = \frac{2\pi}{\lambda}$

As $\beta = \frac{2\pi}{\lambda}$ always

$\therefore$ $\delta = \frac{1}{\alpha} = \frac{1}{\beta} = \frac{1}{2\pi}$

9.What is the value of standing wave ratio (SWR) in free space for reflection coefficient Γ = $-\frac{1}{3}$?

A. $\frac{2}{3}$
B. 0.5
C. 4.0
D. 2.0

Answer ||| D

Solution ||| SWR is defined as

S= $\frac{1+|\Gamma|}{1-|\Gamma|}$

Given that, $\Gamma = -\frac{1}{3} = \frac{1}{3}\angle 180^{\circ}$

$\therefore \quad |\Gamma| = \frac{1}{3}$

$\therefore \quad = \frac{1+1/3}{1-1/3} = 2$

10.Two identical coaxial circular loops carry the same current circulating in the same direction. If the loops approached each other, then the current in

A. Each one of them will increase
B. Both of them will remain the same
C. Each one of them will decrease
D. One will increase while in the other the current will decrease

Answer ||| A

Solution ||| Suppose, 2 identical circular loops carry the same current circulating in clockwise direction, when seen from up side. In this case the lower front of upper loop will behave like north pole and upper front of lower loop will behave like south pole i.e. there will be attraction between the loops and hence these will support the current flowing in each other. So, the current in each of them will increase.

11.A time varying magnetic flux linking a coil is given by $\phi(t) = \frac{A}{8}(3t^3 - 2t^2 + t + 5)$. If an induced emf in the coil is –75 V at t = 6 sec, then find the value of A

A. 2
B. –2
C. 1
D. –1

Answer ||| A

Solution |||

By Faraday's law,

Emf induced, $E = \frac{-d\phi}{dt}$

$\therefore$ $E = \frac{-A}{8}\left[9t^2 - 4t + 1\right]$

at t = 6 sec

$E = -\frac{A}{8}$ $[9 \times 6^2 - 4 \times 6 + 1]$

$E = -\frac{A}{8} \times 301$

Given, E = –75 V

$-75 = -\frac{A}{8} \times 301$

$\Longrightarrow$ A = 2

12.**Statement (I):** The solution of the Poisson's equation is the same as the solution of Laplace equation.

Statement (II): Laplace equation is a special case of Poisson's equation for source free regions.

A. Both statement (I) and statement (II) are true and statement (II) is correct explanation of statement (I)
B. Both statement (I) and statement (II) are true but statement (II) is not a correct explanation of statement (I)
C. Statement (I) is true but statement (II) is false
D. Statement (I) is false but statement (II) is true

Answer ||| D

Solution |||

Statement (I) is false but statement (II) is true

If ρ = 0, Poisson's equation reduces to Laplace equation but solution of Poisson's equation is not same as that of Laplace equation.

13.For a transmission line load matching over a range of frequencies , it is best to use a

A. balun transformer
B. single stub of adjustable
C. double stub
D. broad band directional coupler

Answer ||| C

Solution ||| Balun trsnsfer is used for balance and unbalance line. Double stub (short circuit stub with parallel connection) is best suited for impdance matching because we have 4 matching options. Single stub is also used but having two matching options, so best is double stub.

14.Consider the following statements in connection with boundary relations of electric field:
1) In a single medium electric field is continuous.
2) The tangential components are the same on both sides of a boundary between two dielectrics.
3) The tangential electric field at the boundary of a dielectric and a current carrying conductor with finite conductivity is zero.
4) Normal component of the flux density is continuous across the charge-free boundry between two dielectrics.
Which of these statements is/are correct?

A. 1 only
B. 1, 2 and 3
C. 1, 2 and 4
D. 3 and 4 only

Answer ||| C

Solution ||| According to boundary condition for electric field

$$E_{t_1} = E_{t_2}$$

i.e., tangential component is continuous

$$D_{n_1} - D_{n_2} = -\rho_S$$

if region is charge free ρ_S =0

$$D_{n_1} = D_{n_2}$$

i.e, normal component of flux density is continuous across the charge free boundary. In case of perfect conductor $E_{t_2} =$ 0 since electric field does not exist inside a perfect conductor but in case of finite conductivity it can't be zero so statement 3 is wrong.

15.The equation of continuity defines the relation between

A. Electric field and magnetic field
B. Electric field and charge density
C. Flux density and charge density
D. Current density and charge density

Answer ||| D

Solution ||| Continuity equation

$$\nabla \cdot \vec{J} = -\frac{\partial \rho_v}{\partial t}$$

The above equation relates current density and charge density.

16.A point charge of +5μC and –5μC are located at (0, 0, 1) and (0, 0, –1) respectively, in free space. Find the magnitude of dipole moment. Consider distance in meters.

A. 12 μ Cm
B. 10 μ Cm
C. 8 μ Cm
D. 5 μ Cm

Answer ||| B

Solution |||

Dipole moment $\vec{P} = Q.d\hat{a}_d$

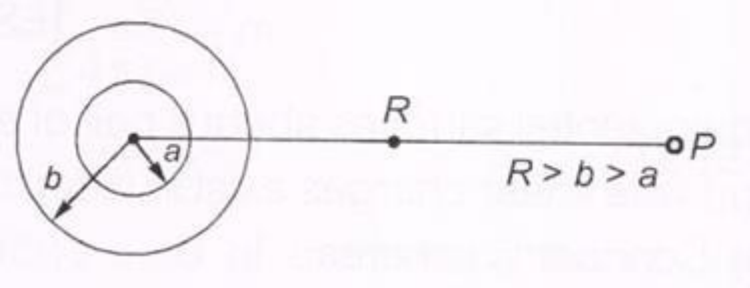
d = 1 – (–1) = 2m

Q = 5 μC

$\vec{P} -= 5\mu \times 2 = 10\mu C - m\hat{a}_z$

|P| = 10 μC -m

17.A spherical balloon of radius a is charged. The energy density in the electric field at a point P shown in the figure given below is w. If the balloon is inflated to a radius b without altering its charge, what is the energy density at P?



A. $w\left(\frac{b}{a}\right)^3$

B. $w\left(\frac{b}{a}\right)^2$

C. $w\left(\frac{b}{a}\right)$

D. w

Answer ||| D

Solution ||| Energy stored $W_e = \frac{1}{2} \in E^2$

$E \propto \frac{1}{R^2}$ where R is distance from center to point 'P'. Due to inflaton of balloon R is not changing

18.An electric dipole is being placed in an electric field intensity $2a_x - a_y$ V/m .

If the moment of the dipole will be

$p = -3a_x + 2a_y$ cm . Find the energy of dipole.

A. $\sqrt{5}$J

B. $\sqrt{11}$J

C. 6 J

D. 8 J

Answer ||| D

Solution |||

Energy of dipole is

W_E = –P · E

$W_E = -(-3a_x + 2ay) \cdot (2a_x - a_y)$ = –(–6 –2) = 8 J

19.Consider the following statements:

1. Differential form of ampere circuit law is $\nabla \times H = J$.

2. Gauss’s law for a homogeneous isotropic medium can be written as $\nabla \cdot J + \rho = 0$.

3. Maxwell equations are extension of the works of Gauss, Ampere and Faraday.

Which of the above statements are correct?

A. 1 and 2
B. 2 and 3
C. 1 and 3
D. 1, 2 and 3

Answer ||| C

Solution |||

Statement 2 is false because the expression given for law is incorrect.

20.A magnetic field $\vec{B} = (\hat{i} + 2\hat{j} - 4\hat{k})$ exist at a point. If a test charge moving $\vec{v} = (3\hat{i} - \hat{j} + 2\hat{k})$ experience no force at a certain point, the electric field at that point will be

A. $7\hat{j} + 14\hat{k}$

B. $-7\hat{j} + 14\hat{k}$

C. $-14\hat{j} - 7\hat{k}$

D. $-14\hat{j} + 7\hat{k}$

Answer ||| C

Solution |||

∵ F = 0

$q(\vec{v} \times \vec{B}) + q\vec{E} = 0$

$E = -\vec{v} \times \vec{B}$

$$E = -\begin{vmatrix} i & j & k \\ 3 & -1 & 2 \\ 1 & 2 & -4 \end{vmatrix} = -[i(4-4) - j(-12-2) + k(6+1)]$$

$\vec{E} = -14\hat{j} - 7\hat{k}$

21.EM wave propagating in a dielectric medium characterized by $\varepsilon_r = 4, \mu_r = 1$ will have a phase velocity in m/s equal to?

A. $c/3$
B. $2c$
C. $0.5c$
D. $c/4$

Answer ||| C

Solution ||| Phase velocity is given by:

$$v_p = \frac{c}{\sqrt{\varepsilon_r * \mu_r}}$$

$$\Rightarrow v_p = \frac{c}{\sqrt{4 * 1}} = \frac{c}{2}\ m/s$$

22.The wave length of a wave in a waveguide is

A. is greater than in free space
B. depends only on the waveguide dimensions and the free-space wavelength
C. is inversely proportional to the phase velocity
D. is directly proportional to the group velocity

Answer ||| A

Solution ||| Wave length of a wave in a wave guide will always be greater than in free space. Guide wavelength is defined as the distance between two equal phase planes along the waveguide. The guide wavelength is a function of operating wavelength (or frequency) and the lower cut-off wavelength, and is always longer than the wavelength would be in free-space.

23.Which of the function for electric potential (V) is said to be harmonic ?

A. $\nabla \times (\nabla V) = 0$
B. $\nabla \cdot (\nabla \times V) = 0$
C. $\nabla \cdot (\nabla V) = 0$
D. $\nabla(\nabla \times V) = 0$

Answer ||| C

Solution |||

Laplacian of electric potential is said to be harmonic if the function $\nabla^2 V$ is zero every where.

24.Determine the energy density in free space created by a magnetic field with intensity H = 10^3 A/m.

A. 314 mJ/m^3
B. 314 $\mu J/m^3$
C. 628 mJ/m^3
D. 628 $\mu J/m^3$

Answer ||| C

Solution |||

For free space,

$H = 10^3$ A/m

Energy density is given as,

$$= \frac{1}{2}\mu_o H^2 \text{ J/m}^3$$
$$= \frac{1}{2}\times 4\pi\times 10^{-7}\times\left(10^3\right)^2 \text{ J/m}^3$$
$$= 2\pi\times 10^{-1} \text{ J/m}^3$$
$$= 6.283\times 10^{-1}\times 10^2\times 10^{-2} \text{ J/m}^3$$
$$= 628.3 \text{ mJ/m}^3$$

25.An air-cored solenoid of 250 turns has a cross-sectional area A = 80 cm^2 and length l = 100 cm. The value of its inductance is

A. 0.425 mH
B. 0.628 mH
C. 0.751 mH
D. 0.904 mH

Answer ||| B

Solution |||

Inductance (L)= $\frac{\mu_0 N^2 A}{l}$

Putting all the values

$$L = \frac{\mu_0\times 250^2\times 80\times 10^{-4}}{100\times 10^{-2}}$$
$$= 0.628\, mH.$$

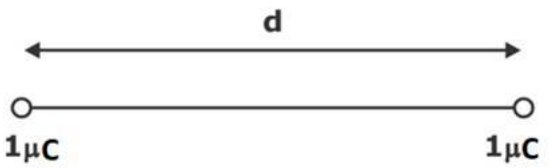
26.If the weight of 1 kg mass on earth and repulsive force between 1 μC charges are equal. Then distance between 1 μC charges should be ______ cm.

A. 1
B. 2
C. 3
D. 4

Answer ||| C

Solution |||

Let distance = d



So, Force = $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{d^2}$

And this force = mg

Gives $d^2 = \frac{Q^2}{4\pi\varepsilon_0 mg} \Rightarrow d = \sqrt{\frac{Q^2}{4\pi\varepsilon_0 mg}}$

Putting values $d = \sqrt{\frac{9\times10^9\times\left(1\times10^{-6}\right)^2}{9.8\times1}} = 0.03\text{ m} = 3\text{ cm}$

27.For an infinite current sheet consider

(i) location, y = 1 plane

(ii) uniform current density carried = $-40\hat{k}$ mA/m

Based on above data, at (x, y, z) = (2, 9, –3) meter magnetic field intensity will be_______.

A. 20 $\hat{i}$ mA/m
B. –20 $\hat{i}$ mA/m
C. 10 $\hat{i}$ mA/m
D. –10 $\hat{i}$ mA/m

Answer ||| A

Solution |||

Given $\vec{k} = -40\bar{z}$ mA/m

Magnetic field intensity

$\vec{H} = \frac{\vec{k}\times\hat{a}_n}{2}$ (where, $\hat{a}_n$ is the perpendicular unit vector from sheet to point)

So, $\hat{a} - \hat{y}$

$$\bar{H} = \frac{-40\hat{z} \times (\hat{y})}{2} = 20\hat{x}\ (mA/m)$$

or $20\hat{i}\ (mA/m)$

28.The energy stored in a solenoid is 25 J. It is 20 cm long and has a diameter of 3 cm and wound with 1500 turns of wire. Determine the approximate current carried by the solenoid. (Consider $\pi^2 \approx 10$)

A. 42.29 A
B. 118.28 A
C. 70.27 A
D. 17.84 A

Answer ||| C

Solution ||| Inductance of solenoid,

$$L = \frac{\mu_0 N^2 A}{\ell} = \frac{\mu_0 N^2 (\pi r^2)}{\ell}$$

$$L = \frac{4\pi \times 10^{-7} \times (1500)^2 \times \pi(1.5 \times 10^{-2})^2}{20 \times 10^{-2}}$$

L = 10.125 mH

Energy stored $= \frac{1}{2}LI^2$

$$25 = \frac{1}{2} \times 10.125 \times 10^{-3} I^2$$

$I^2 = 4938.27$

I = 70.27 A

29.Determine the capacitance of isolated spherical conductor of radius 18 cm.

A. 2 pF
B. 0.2 pF
C. 20 pF
D. 200 pF

Answer ||| B

Solution |||

Capacitance of isolated spherical conductor

$C = 4\pi\epsilon_0 R$

$$C = \frac{1}{9 \times 10^9} \times 18 \times 10^{-2}$$

$C = 2 \times 10^{-11}$ F

C = 20 pF

30.The separation between the plates of a capacitor is ‘d’. A dielectric slab of thickness $\frac{d}{3}$ and dielectric constant 5 is inserted between the plates of the capacitor. After insertion of dielectric, capacitance becomes λ times the original capacitance. Determine the value of λ.

A. 5
B. $\frac{22}{15}$
C. $\frac{22}{15}$
D. $\frac{15}{11}$

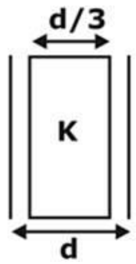
Answer ||| D

Solution |||

Before insertion of dielectric,

Capacitance $= C = \frac{\epsilon_0 A}{d}$

When a dielectric slab is inserted,



Capacitance, $= C' = \frac{\epsilon_0 A}{(d-t)+\frac{t}{k}}$

Where t is the thickness of slab

Here, t = d/3, K = 5

$$\therefore C' = \frac{\epsilon_0\ A}{\left(d-\frac{d}{3}+\frac{d}{15}\right)}$$

$$C' = \frac{15}{11}\frac{\epsilon_0\ A}{d} = \frac{15}{11}C$$

$$C' = \lambda C$$

$$\therefore \lambda = \frac{15}{11}$$

31.Consider two long parallel conductors placed at a certain distance apart from each other. The current carried by one wire is doubled and the current carried by the other wire is tripled. Also, the distance between them is reduced to half. Find the % change in force per unit length between the two wires.

A. 1200
B. 1100
C. 1000
D. 900

Answer ||| B

Solution |||

Force per unit length between two conductors is given by,

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$\Rightarrow \quad F \propto= \frac{I_1 I_2}{d}$$

$$\therefore \quad \frac{F'}{F} = \frac{I_1'}{I_1} \times \frac{I_2'}{I_2} \times \frac{d}{d'}$$

Given, $I_1' = 2I_1, I_2' = 3I_2 \text{ and } d' = \frac{d}{2}$

$$\Rightarrow \frac{F'}{F} = \frac{2I_1}{I_1} \times \frac{3I_2}{I_2} \times \frac{d}{d/2}$$

$\Rightarrow F' = 12F$

% Change = $\left(\frac{F' - F}{F}\right) \times 100$

$$= \frac{12F - F}{F} \times 100$$

= 1100%

32.Where is the Laplace's equation valid?

A. Only in free space
B. Only in conductors
C. Only in charge free dielectric regions
D. Only in cavities bounded on all sides by conducting walls

Answer ||| C

Solution ||| Laplace's equation is all-embracing, for applying as it does where volume charge density is zero, it states that every conceivable configuration of electrodes or conductors produces a field for which $\nabla^2 V = 0$.

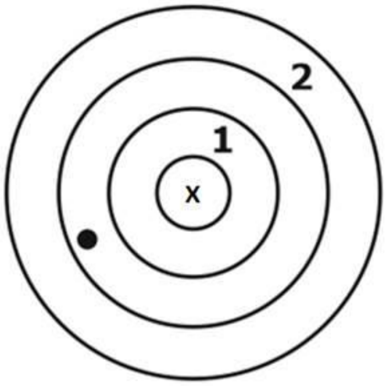
33.Consider the following statements regarding a conductor and free space boundary:
1) No charge and no electric field can exist at any point within the interior of a conductor
2) Charge may appear on the surface of a conductor
Which of the above statements are correct?

A. 1 only
B. 2 only
C. Both 1 and 2
D. Neither 1 nor 2

Answer ||| C

Solution ||| Net Electric field inside a conductor is ‘0’ only when charges are stationary but, in a conductor there are free charges which keep moving, if there is an electric field. Hence, if the charges has to remain stationary there should be no electric field or net charges must be zero. Charge may appear on the surface of a conductor due to the repulsive force between electron.

34.It is given that current flowing on centre conductor 1, is 10A & 8A at outer conductor then the value of magnetic field intensity at the region (r) middle of (1) & (2) is-



A. $\frac{5}{r\pi}$

B. $\frac{10}{r\pi}$

C. $\frac{15}{r\pi}$

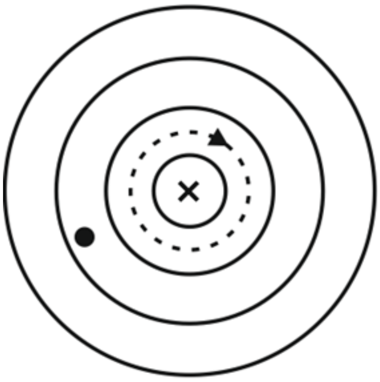
D. $\frac{20}{r\pi}$

Answer ||| A

Solution |||

Apply Ampere’s law

$\int H.dl = I_{enclosed}$



Make an amperian path as showing figure at r distance.

$$H \cdot 2\pi r = I$$

$$H = \frac{10}{2\pi r} = \frac{5}{r\pi}$$

35.An elliptically (arbitrarily) polarized wave can be broken up into

A. Two circularly polarized components rotating in same direction
B. Two circularly polarized components rotating in opposite directions
C. Two stationary circularly polarized components
D. None of these

Answer ||| B

Solution |||

A plane-polarized wave with its plane rotated 90° will propagate with To see what happens, resolve the incident field into components polarized along a plane-polarized wave, but making an angle θ on the opposite side of the fast axis. Setting up a wave plate to produce circularly polarized light proceeds exactly. Horizontal components of the resultant radio wave may have arbitrary values. In this case, the resultant radio wave will become elliptically polarized (i.e., ... po— larized radio waves with the same frequency and propagation direction, and ... be decomposed into two mutually opposite circularly polarized radio waves.

36.It consists of two statements, one is statement (I) and other is statement (II) examine these two statements carefully and select the answer to these items using the codes given below:

Statement (I) For a varying magnetic, field electric field & magnetic field is related as $\nabla \times E = \frac{-dB}{dt}$

Statement (II) Capacitor opposes the sudden change in voltage across it.

A. Both statement (I) and statement (II) are individually true and statement (II) is the correct explanation of statement (I)
B. Both statement (I) and statement (II) are individually true but statement (II) is not correct explanation of statement (I)
C. Statement (I) is true but statement (II) is false
D. Statement (I) is false but statement (II) is true

Answer ||| B

Solution |||

⇒ for varying magnetic field $\nabla \times E = \frac{-dB}{dt}$

⇒ capacitor opposes sudden change in voltage across it

⇒ as both statement are true but they not related to each other

37.The electric flux density in a region is $D = \frac{1}{Z}[3x^2yz\ \hat{a}_x + 4xy\hat{a}_x + 3y^2\hat{a}_z].$ The volume charge density at (1, 5, –2) is

A. 18.5 c/m^3
B. 28 c/m^3
C. 9.25 c/m^3
D. 14 c/m^3

Answer ||| C

Solution |||

$\int \bar{D} \cdot d\bar{s} = Q$

Using divergence theorem

$\int \nabla D \cdot dv = Q$

$$\nabla \cdot D = \frac{\partial}{\partial x}(3x^2y) + \frac{\partial}{\partial y}\left(\frac{4xy}{Z}\right) + \frac{\partial}{\partial z}\left(\frac{3y^2}{Z}\right)$$

$$= 6xy + \frac{4x}{Z} - \frac{3y^2}{Z^2}$$

At (1, 5, –2)

$$\nabla \cdot D = 30 + \frac{4}{-2}\frac{-3 \times 25}{4}$$

$$= 30 - 2 + \frac{-75}{4} = 28 - 18.75$$

= 9.25

$$\nabla \cdot D = \frac{Q}{V} = \delta_V$$

Hence, $\delta_V = 9.25\ C/m^3$

38.An electric field is given by $E = zy^2\hat{a}_x + 2xyz\hat{a}_y + y^2x\hat{a}_z V/m$, an incremental path is represented by $\Delta L = -2\hat{a}_x + 3\hat{a}_y + 2\hat{a}_z \mu m$. Find the work done in moving 4μC charge along the incremental path if the location of the path is a point (2, 1, 1)

A. –28 pJ
B. 28 pJ
C. –56 pJ
D. 56 pJ

Answer ||| C

Solution |||

Work done in moving qC charge ⟶

W = –q (E. ΔL)

q = 4μC

$$E = zy^2\hat{a}_x + 2xyz\hat{a}_y + y^2x\hat{a}_z$$

$$\Delta L = -2\hat{a}_x + 3\hat{a}_y + 2\hat{a}_z \mu m$$

$w = -4 \times 10^{-6}\left[zy^2\hat{a}_x + 2xyz\hat{a}_y + y^2x\hat{a}_z\right]\left[-2\hat{a}_x + 3\hat{a}_y + 2\hat{a}_z\right] \times 10^{-6}$

$= -4 \times 10^{-12}[-2zy^2 + 6xyz + 2y^2x]$

$W_{at}(2,1,1) = -4 \times 10^{-12}[(-2 \times 1 \times (1)^2) + 6 \times (2 \times 1 \times 1) + 2(1)^2 \times 2]$

$= -4 \times 10^{-12}[-2 + 12 + 4]$

= –56 pJ

39.In practice, Earth is chosen as a place of zero electric potential because it

A. is non-conducting
B. is easily available reference
C. keeps losing and gaining electric charge every day
D. has alomost constant potential

Answer ||| D

Solution ||| In practice, Earth is chosen as a place of zero electric potential because it has almost constant potential.

40.The magnetic induction (B) of a circular wire loop with radius R having current I on axis of loop at a distance q from center of loop will be:

A. $B_z = \mu_0 R^2/(2q^3)$
B. $B_z = \mu_0 IR/(2q^3)$
C. $B_z = \mu_0 IR^2/(2q)$
D. $B_z = \mu_0 IR^2/(2q^3)$

Answer ||| D

Solution ||| As per Biot-Savart law
$dB_z(r) = (\mu_0/4\pi)[Idl \times (q-q')/|q-q'|^3] \cdot k$
On z-axis r = zq
As per symmetry $B = B_z k$ on z-axis
$dB_z = (\mu_0/4\pi) \times [IR^2 d\Phi/(R^2+q^2)^{3/2}]$
On integrating we get
$B_z = \mu_0 I/(2R)$ and for q = R we have
$B_z = \mu_0 IR^2/(2q^3)$

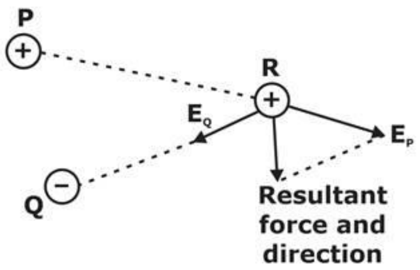
41.An electric charge is located at a point P. Consider electric field intensity E and electric potential V at a point Q. Then _____

A. V and E both are Scalar
B. V is neither vector nor scalar as V=0 at any point beyond P
C. E is a vector
D. V is a vector

Answer ||| C

Solution |||

Electric field intensity is the strength of an electric field at any point. It is equal to the electric force per unit charge experienced by a positive test charge placed at that point. Since it is a force and hence a specific direction.



Electric potential is a Scalar quantity; the reason is lies in its definition. The Electric Potential is defined as the amount of work-done per unit positive charge to bring from infinity to that point.

Also work done is a dot product of force and displacement.

42.Which of the Maxwell equation is modified to eliminate the inconsistency of continuity equation for time varying field?

A. $\nabla \cdot \bar{D} = \rho_V$
B. $\nabla \cdot \bar{B} = 0$
C. Faraday’s law
D. Ampere’s law

Answer ||| D

Solution |||

Ampere’s law for static field is:

$\nabla . \bar{H} = J$

Now divergence of curl of any vector is zero.

$$\nabla . \left(\nabla \times \bar{H}\right) = \nabla \cdot \bar{J} = 0 \qquad \ldots\ldots\ldots..(1)$$

But continuity equation of current is given by:

$$\nabla \cdot \bar{J} = -\frac{\partial \rho_v}{dt} \qquad \ldots\ldots\ldots..(2)$$

So, equation 1 and 2 are not compatible for time varying condition.

Therefore, the ampere's law is modified as

$$\nabla \times \bar{H} = \bar{J} + \bar{J}_d$$

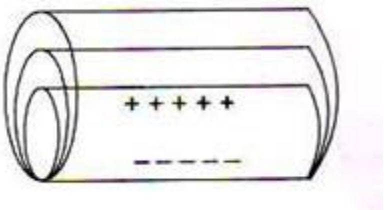
Here, $\bar{J}_d = \frac{\partial \bar{D}}{dt}$ is displacement current density.

43.Consider a long line charge of λ Coulomb/meter perpendicular to the plane of a paoer. The electric field lines and equipotential surfaces are respectively

A. radial, cylindrical concentric with line charge
B. cylindrical concentric with line charge, radial
C. radial, radial but opposite in direction
D. concentric with line charge, parallel to line charge

Answer ||| A

Solution ||| The electric fields lines for a long line charge is always radial also equipotential surface will be formed by concentric cylinders which cover boththe line charges as shown in the diagram.



44.Image theory is applicable to

A. Electrostatic field only
B. Magneto static field only
C. Both electrostatic and magnetic static fields
D. None of the above

Answer ||| A

Solution |||

The electrostatic field has a tangential and normal component. The tangential component displaces electrons on the conductor surface hence charges are periodically accumulated on the entire conductor surface. This can be calculated by image charge.

45.Which of the following is true for magnetic field ?

A. $\bar{B} \cdot \overline{dl} = 0$
B. $\oint \bar{B} \cdot \overline{ds} = 0$
C. $\nabla \times \bar{B} = 0$
D. $\nabla . \bar{B} \neq 0$

Answer ||| B

Solution |||

We know that a magnetic monopole never exists

So, $\oint \bar{B} \cdot \overline{ds} = 0$

46.Which of the following option is correct for Lorentz force ?

A. $\bar{F} = q\bar{E}$
B. $\bar{F} = q\left(\bar{v} \times \bar{B}\right)$
C. $\bar{F} = I\left(\bar{\ell} \times \bar{B}\right)$
D. $\bar{F} = q\left(\bar{E} + \bar{v} \times \bar{B}\right)$

Answer ||| D

Solution |||

For a moving charge Q in presence of both electric & magnetic field, total force acting on a charge is known as Lorentz force

So, $\vec{F} = q\left(\vec{E} + \vec{v} \times \vec{B}\right)$

47.The transmission line of characteristic impedance $50\ \Omega$ is feeding a purely resistive load of $200\ \Omega$. The VSWR on the line is?

A. 1
B. 4
C. 2
D. 0

Answer ||| B

Solution |||

Since $Z_L > Z_o$, VSWR is given by:

$$VSWR = \frac{Z_L}{Z_o}$$

$$\Rightarrow VSWR = \frac{200}{50} = 4$$

48.Consider the following statements:

1. The magnitude of magnetic field strength H is independent of permeability of the medium.

2. A non-zero value of rate of change of magnetic flex maybe due to relative motion between a steady flux and a closed path.

3. Electric flux through a surface area is the integral of parallel component of the field over the area.

Which of the above statements is/are correct?

A. Only 1
B. 1 and 2
C. 2 and 3

D. 1, 2 and 3

Answer ||| B

Solution |||

H is independent of permeability of medium, but B depends on it

H = μB but $B \, \alpha \, \frac{1}{\mu}$

Hence H in independent of μ

If there is relative motion between flux and closed-path then flux linkage might change due to motion.

Electric flux through a surface $= \int \bar{E} \, d\bar{s}$

Where, $d\bar{s}$ is the differential area perpendicular to the surface.

49.Select the correct statement about Gauss Divergence theorem

A. it convert line integral to surface integral
B. it converts line integral to volume integral
C. it convert surface integral to volume integral
D. None

Answer ||| C

Solution |||

Gauss Divergence Theorem

$\Rightarrow \oint_S F.dS = \int_V (\nabla.F) \, dV$

⇒ it convert surface integral to volume internal

50.What is the reluctance of the material with a MMF of 4.2 units and flux of 6 units.

A. 0
B. 25.2

C. 0.7
D. 1.42

Answer ||| C

Solution |||

Reluctance, $s = \frac{\text{mmf}}{\text{flux}} = \frac{4 \cdot 2}{6} = 0.7$

51.Consider the following statements in connection with electromagnetic wsves :
1) Conducting medium behaves like an open circuit to the electromagnetic field.
2) At radio and microwave frequencies the relaxation time is much less then the period
3) in loss-less dielectric the relaxation time is infinite.
4) Intrinsic impedance of a perfect dielectric medium is a pure resistance.
Which of these statements is/are correct ?

A. 1 only
B. 1 and 2 only
C. 2 and 3 only
D. 2, 3 and 4

Answer ||| D

Solution ||| Relaxation time, $T_r = \frac{\in}{\sigma}$

For loss less dielectric $\sigma = 0$

$\therefore \; T_r = \infty$

Intrinsic impedance of a general medium

$$\eta = \sqrt{\frac{j\omega\mu}{\sigma + j\omega \in}}$$

For perfect dielectric $\sigma = 0$

$\therefore \; \eta = \sqrt{\frac{\mu}{\in}}$

Real quantity so pure resistance so is correct so option D.

52.A point $P(5,\frac{\pi}{3},\frac{\pi}{6})$ in spherical coordinate system, if represented in Cartesian coordinate system, then it is given as

A. $\left(\frac{15}{4},\frac{5}{4},\frac{5}{2}\right)$
B. $\left(\frac{15}{4},\frac{5}{4},\frac{5\sqrt{3}}{4}\right)$
C. $\left(\frac{15}{4},\frac{5\sqrt{3}}{4},\frac{5}{2}\right)$
D. $\left(\frac{15}{4},\frac{5}{4},\frac{5\sqrt{3}}{2}\right)$

Answer ||| C

Solution |||

Given that:

$$(r,\theta,\varphi) = \left(5,\frac{\pi}{3},\frac{\pi}{6}\right)$$

Cartesian coordinates are given by:

$$x = rsin\varphi cos\theta$$

$$\Rightarrow x = 5sin\frac{\pi}{3}cos\frac{\pi}{6} = \frac{15}{4}$$

$$y = rsin\varphi sin\theta$$

$$\Rightarrow y = 5sin\frac{\pi}{3}sin\frac{\pi}{6} = \frac{5\sqrt{3}}{4}$$

$$z = rcos\varphi$$

$$\Rightarrow z = 5cos\frac{\pi}{6} = \frac{5}{2}$$

$$\Rightarrow (x,y,z) = \left(\frac{15}{4},\frac{5\sqrt{3}}{4},\frac{5}{2}\right)$$

53.The tangential component of magnetic field intensity at the interface between two surface is

A. Always continuous
B. Continuous if than are no current flow on surface
C. Always discontinuous
D. None

Answer ||| B

Solution |||

We know that at boundary, tangential component of H is equal to

$H_{1t} – H_{2t} = k \times a_n$

if current density k is zero,

then $H_{1t} = H_{2t}$

54.In rectangular coordinates, a vector is given by $\bar{B} = y\hat{a}_x + (z + x)\hat{a}_y$, then the z component of the vector in cylindrical coordinates will be:

A. Zero
B. Z
C. y cosθ + (z + x)sinθ
D. –y sinθ + (z + x)cosθ

Answer ||| A

Solution |||

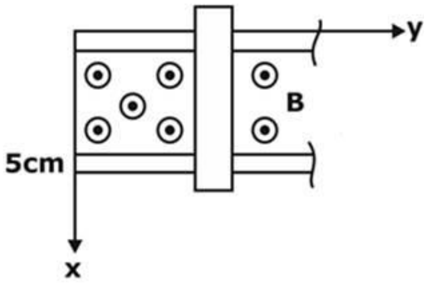
Relation between (A_x, A_y, A_z) and (A_s, A_Q, A_z) are:

$$\begin{bmatrix} A_S \\ A_Q \\ A_Z \end{bmatrix} = \begin{bmatrix} Cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} A_X \\ A_y \\ A_Z \end{bmatrix}$$

Z component remains same as that of rectangular coordinate system:

$A_Z = 0$

55.A conducting bar can slide freely over two conducting rails as shown in the figure below. Calculate the voltage induced in the bar if the bar is stationed at y = 12 cm and B = 15 cos 10^3 t $\hat{a}_z$ m Wb/m^2,



A. 90 sin 10^3t mV
B. –9 sin 10^3t mV
C. –90 sin 10^3t mV
D. 9 sin 10^3t mV

Answer ||| A

Solution ||| In this case, voltage induced in the bar is called as transformer emf and it is given as,

$$V = -\int \frac{\partial B}{\partial t} \cdot dS$$

$$-\frac{\partial B}{\partial t} = -\frac{\partial}{\partial t}(15 \times 10^{-3} \cos 10^3 t)$$

= 15 sin 10^3 t

$$V = \int_{y=0}^{0.12} \int_{x=0}^{0.05} 15 \sin 10^3 t \, dxdy$$

V = 15 × 0.5 × 0.12 sin 10^3t

V = 90 sin 10^3t mV

56.When currents are moving in the same direction in two conductors, then the force will be

A. Opposing
B. Attractive
C. Repulsive
D. Depends on the direction of magnetic field

Answer ||| B

Solution |||

An attractive force is applied between two conductors if the current flows in same direction.

57.A vector magnetic potential is given by:

$\bar{A} = 10\sin\theta \hat{a}_\theta \ Wb/m$

The magnetic flux density at $\left(2, \frac{\pi}{2}, 0\right)$ will be

A. 0

B. $5\hat{a}_\phi \ Wb/m^2$

C. $10\hat{a}_r \ Wb/m^2$

D. $-10\hat{a}_\phi \ Wb/m^2$

Answer ||| B

Solution |||

The magnetic flux density:

$\bar{B} = \bar{\nabla} \times \bar{A}$

$$= \frac{1}{r^2 \sin\theta} \begin{vmatrix} \hat{a}_r & r\hat{a}_\theta & r\sin\theta \hat{a}_\phi \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial \theta} & \frac{\partial}{\partial \phi} \\ 0 & r(10 \sin\theta) & 0 \end{vmatrix}$$

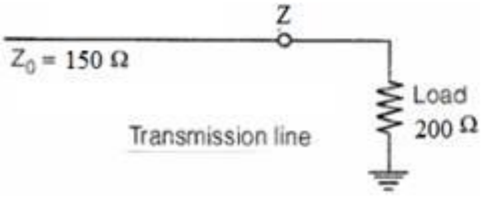
$$= \frac{1}{r^2 \sin\theta} \left[r\sin\theta \, \hat{a}_\phi (10 \sin\theta) \right]$$

$$\bar{B} = \frac{10\sin\theta}{r} \hat{a}_\phi$$

$\bar{B}$ at $\left(2, \frac{\pi}{2}, 0\right)$

$$\bar{B} = \frac{10\sin\left(\frac{\pi}{2}\right)}{2} \hat{a}_\phi = 5\hat{a}_\phi \ Wb/m^2$$

58.Find the reflection coefficient of transmission line at point Z?

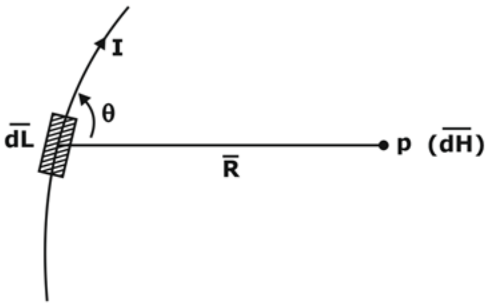


A. 1.25
B. 0.14
C. 2.25
D. 0.5

Answer ||| B

Solution ||| In a transmission line, reflection coefficient will be:
$Z_L – Z_O / Z_L + Z_O$
= 200 – 150 / 200 + 150
= 50 / 350
= 0.14

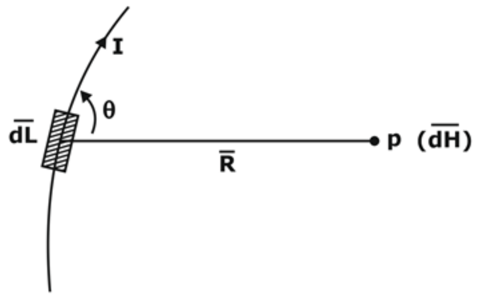
59.Magnetic field intensity at any point P due to the current element is proportional to



A. current flowing through the conductor
B. length of conductor
C. sin θ (where θ is angle b/w length & unit normal vector)
D. All

Answer ||| D

Solution |||



⇒ Magnetic field intensity at point P is given by Biot-Savart Law

$$\overline{dH} = \frac{I\overline{dL} \times \overline{R}}{4\pi R^3}$$

(or)

$$\boxed{\overline{dH} \propto \frac{I d\overline{\ell} \sin\theta}{R^2}}$$

60.A 20 μC point charge is located at origin. Calculate electric flux passing through the portion of sphere defined by r = 10 cm, bounded by θ = 0 and π rad, ϕ = 0 and π/2 rad.

A. 5 μC
B. 10 μC
C. 15 μC
D. 20 μC

Answer ||| A

Solution |||

For given sphere, r = 10 cm

ϕ ⇒ 0 to π/2 rad

Normally ϕ varies 0 to 2π rad,

θ → 0 to π rad.

Hence given sphere is a quarter sphere.

Flux crossing closed surface = $Q_{enclosed}$

Total charge = 20 μC

Charge enclosed by a quarter sphere = $\frac{20\mu C}{4} = 5\mu C$

61.The ratio of the transverse electric field to the transverse magnetic field is called as

A. waveguide impedance
B. waveguide wavelength
C. phase velocity
D. Poynting vector

Answer ||| A

Solution ||| $\eta = \frac{E}{H}$ = waveguide impedance

62.Match List-I with List-II and select the correct answer using the code given below the lists:
List-I List-II
A- Line charge 1. Maxwell
B- Magnetic flux 2. Poynting density vector
C- Displacement 3. Biot-savart's current law
D- Power flow 4. Gauss's law
Codes:
A B C D

A. 1 2 4 3
B. 4 3 1 2
C. 1 3 4 2
D. 4 2 1 3

Answer ||| B

Solution ||| (i) According to Biot-Savart's law the magnetic flux density

$$B = \frac{\mu I}{4\pi} \oint_c \frac{ds \times \hat{R}}{R^2}$$

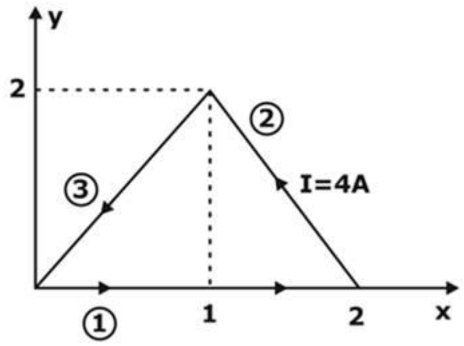
(ii) Poynting vector

$$\vec{P} = \vec{E} \times \vec{H}$$

Poynting theorem states that the vector product $\vec{P} = \vec{E} \times \vec{H}$ at any point is a measure of the power flow per unit area at that point.

The direction of flow is perpendicular to $\vec{E}$ and $\vec{H}$ in the direction of the vector $\vec{E} \times \vec{H}$.

63.The conducing triangular loop as shown below carries a current of 4A. The magnitude of magnetic field intensity $\bar{H}$ at (0, 0, 5) due to side (3) of the loop is



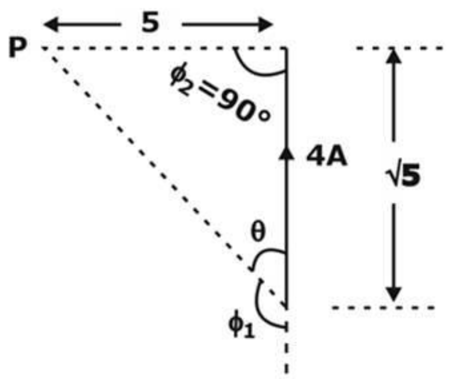
A. 24 mA/m
B. 26 mA/m
C. 18 mA/m
D. 28 mA/m

Answer ||| B

Solution |||

Length of section = $\sqrt{1^2+2^2}=\sqrt{5}$

Section 3 can be drawn as



$\theta = \tan^{-1}\left(\frac{5}{\sqrt{5}}\right)$ = 65.9°

$\phi_1 = 180 – 65.9 = 141.1°$

$$\bar{H} = \frac{I}{4\pi\rho}[\cos\phi_2 - \cos\phi_1]$$
$$= \frac{4}{4\pi \times 5}[\cos\ 90 - \cos\ 114.1] = 26\ mA / m$$

64.If electric potential, V = (2x + 8y + 7z) volts, then electric field intensity at (1, 1, 2) is

A. $-2\hat{\imath} - 8\hat{\jmath} - 7\hat{k} V/m$
B. $8\hat{\imath} + 2\hat{\jmath} + 7\hat{k} V/m$
C. $3\hat{\imath} + 5\hat{\jmath} + 8\hat{k} V/m$
D. 0 V/m

Answer ||| A

Solution |||

Electric field intensity

$$E = -\nabla \cdot V$$

$$= -\left[\frac{\partial}{\partial x}\hat{\imath} + \frac{\partial}{\partial y}\hat{\imath} + \frac{\partial}{\partial z}\hat{k}\right](2x + 8y + 7z)$$

$$E = -2\hat{\imath} - 8\hat{\jmath} - 7\hat{k} V/m$$

65.Consider the following:
1) Electric current flowing in a conducting wire
2) A moving charged belt
3) An electron beam in a cathode ray tube
4) Electron movement in a vacuum tube
Which of the above are examples of convection current?

A. 2, 3 and 4 only
B. 1, 2 and 4 only
C. 1 and 3 only
D. 1, 2, 3 and 4

Answer ||| A

Solution ||| Convection is one of the type of heat transfer apart from conduction and radiation. Convection happens only in liquids and gases as there the molecules are free to move. When there is a huge temperature difference between two points or parts in liquid/gas then, heat is transferred and convection current flows.
Out of the given options the options 2, 3 and 4 satisfies the above criteria.

66.The capacitance of a concentric spherical capacitor of shell radii *x* and *y* (*x* × *y*) is

A. $\frac{1}{4\pi\varepsilon_0} \ln \frac{x}{y}$

B. $\frac{4\pi\varepsilon_0 xy}{x-y}$

C. $4\pi\varepsilon_0 \ln \frac{y}{x}$

D. $\frac{1}{4\pi\varepsilon_0}\left[\frac{1}{y}-\frac{1}{x}\right]$

Answer ||| B

Solution ||| $V = \frac{Q}{4\pi \cos}\left[\frac{1}{y}-\frac{1}{x}\right]$

Q = CV

$$C = \frac{Q}{V} = \frac{Q}{\frac{Q}{4\pi \cos}\left[\frac{1}{y}-\frac{1}{x}\right]}$$

$$= \frac{4\pi \cos xy}{x-y}$$

67.According to Gauss's Law, the surface integral of the normal component of electric flux density D over a closed surface containing charge Q is

A. $\frac{Q}{\varepsilon_0}$
B. $\varepsilon_0 Q$
C. Q
D. $\frac{Q^2}{\varepsilon_0}$

Answer ||| C

Solution ||| Gauss's law states that the total electric flux ψ through any closed surface is equal to the total charge enclosed by that surface

$$\psi = Q_{enclosed}$$

$$Q = \int_s D \cdot ds$$

68.Six capacitors of different cfapacitances C_1, C_2, C_3, C_4, C_5 and C_6 are connected in series $C_1 > C_2 > C_3 > C_4 > C_5 > C_6$. What is the total capacitance almost equal to?

A. C_1
B. C_3
C. C_4
D. C_6

Answer ||| D

Solution ||| Net capacitance C is given by, for series connection.

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4} + \frac{1}{C_5} + \frac{1}{C_6}$$

$$\because C_1 > C_2 > C_3 > C_4 > C_5 > C_6$$

$$\therefore \frac{1}{C_1} < \frac{1}{C_2} < \frac{1}{C_3} < \frac{1}{C_4} < \frac{1}{C_5} < \frac{1}{C_6}$$

$$\therefore \frac{1}{C} \simeq \frac{1}{C_6}$$

$$\therefore C \cong C_6$$

69.Consider a scalar field V given in cylindrical co-ordinate (ρ, ϕ, z), V = $5\rho^2 \sin 2\phi$,

Laplacian of V at $\left(\rho = 1, \phi = \frac{\pi}{4}, z = 0\right)$ is

A. 6
B. 0
C. 12
D. 4

Answer ||| B

Solution |||

$$\nabla^2 V = \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho \frac{\partial V}{\partial \rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 V}{\partial \phi^2} + \frac{\partial^2 V}{\partial z^2}$$

$$\nabla^2 V = \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho \cdot 10\rho \sin 2\phi\right) + \frac{1}{\rho^2} 5\rho^2\left(-4\sin 2\phi\right) + 0$$

$$\nabla^2 V = 20 \sin 2\phi - 20 \sin 2\phi = 0$$

$$\nabla^2 V = 0$$

70.What is the volume charge density at P(3, 2, 1) associated with electric flux $D = xy^2\hat{a}_x + yx^2\hat{a}_y + z^2\hat{a}_z c/m^2$

A. 10 c/m^3
B. 12 $/m^3$
C. 8 c/m^3

D. 15 c/m^3

Answer ||| D

Solution |||

Given, $D = xy^2\hat{a}_x + yx^2\hat{a}_y + z^2\hat{a}_z c/m^2$

Volume charge density $\rho_v = \nabla . V$

$$\rho_v = \left[\frac{\partial}{\partial x}\hat{\imath} + \frac{\partial}{\partial y}\hat{\jmath} + \frac{\partial}{\partial z}\hat{k}\right]\left[xy^2\hat{a}_x + yx^2\hat{a}_y + z^2\hat{a}_z\right]$$

= $y^2 + x^2 + 2z$

ρ_v at P(3, 2, 1)

$\rho_v = (2)^2 + (3)^2 + 2x1$

= 4 + 9 + 2

= 15 c/m^3

71.When a plane wave propagates in a dielectric medium ?

A. The average electric energy and the average magnetic energy densities are not equal
B. The average electric and the average magnetic energy densities are equal
C. The net average electric density is finite
D. The average electric energy density is not dependent on the average magnetic energy density

Answer ||| B

Solution ||| When plane wave propagate in dielectric (losses we can assume to zero) so average electric energy density and magnetic energy density will be equal.

72.Choose the correct statement(S)

1) If $\nabla \times \vec{A} = 0$ it shows that $\vec{A}$ is conservative field.

2) In order to have divergence, there should be source or sink at that particular point.

3) A moving charge with uniform velocity produces time varying magnetic field

A. 1 only
B. 1 and 2 only
C. 2 and 3 only
D. 3 only

Answer ||| B

Solution |||

A moving charge with uniform velocity produces constant magnetic field

73.Work done by 2 μC charge to move along path defined by $\Delta\bar{l}$ at (1, 1, 1) is _____ pJ, provided

(i) Electric field = $6y^2z\hat{i} + 12xyz\hat{j} + 6xy^2\hat{k}$ (V/m) and

(ii) $\Delta\bar{L} = \left(-3\hat{i} + 5j - 2\hat{k}\right) \times 10^{-6}$ meter

A. 60
B. –60
C. 180
D. –180

Answer ||| B

Solution |||

$\bar{E} = 6v^2z\hat{i} + 12\ xvz\hat{i} + 6xv^2\hat{k}$

at (1, 1, 1)

$\bar{E} = 6\hat{i} + 12\hat{j} + 6\hat{k}$ (V/m)

So $\overline{dW} = -Q\left(\bar{E} \cdot \overline{d\ell}\right)$

$W = -2 \times 10^{-6} \times \left[\left(6\hat{i} + 12\hat{j} + 6\hat{k}\right) \cdot \left(-3\hat{i} + 5\hat{j} - 2\hat{k}\right) \times 10^{-6}\right]$

$W = -60 \times 10^{-12}$ J or –60 pJ

74.A long, straight wire carries a current I = 50A . At what distance the magnetic field is 2 A/m?

A. 6.98 m
B. 3.97 m
C. 4.08 m
D. 5.15 m

Answer ||| B

Solution |||

Magnetic field intensity at d distance from the wire

$$H = \frac{I}{2\pi d}$$

$$2 = \frac{50}{2\pi d}$$

$$d = 3.97\,\text{m}$$

75.A point charge of 5μC is located at origin and another point charge of –5μC is a located at (1, 1, 1). The potential at (0, 1, 0) is

A. 76.185×10^3 V
B. 13.18×10^3 V
C. 13.18 V
D. 76.185 V

Answer ||| B

Solution |||

Potential at a point = $\frac{1}{4\pi\varepsilon_0}\frac{q}{r}$

Distance between (0, 0, 0) and (0, 1, 0) = 1

Distance between (1, 1, 1) and (0, 1, 0) = $\sqrt{2}$

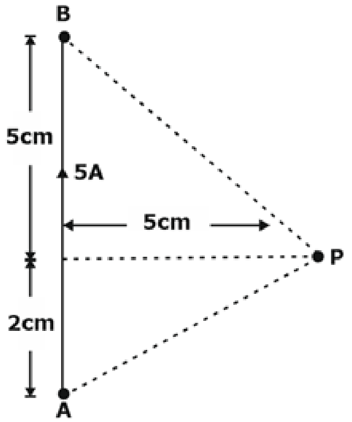
Potential at (0, 1, 0) = $V_1 + V_2$ $= \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{r_1} + \frac{q_2}{r_2}\right]$

$$= 9 \times 10^9 \left[\frac{5 \times 10^{-6}}{1} - \frac{5 \times 10^{-6}}{\sqrt{2}}\right]$$

$$= 45 \times 10^3 \left[1 - \frac{1}{\sqrt{2}}\right]$$

$= 45 \times 10^3$ [0.293] $= 13.18 \times 10^3$ V

76.Find the magnetic field intensity at point P. If I = 5A.



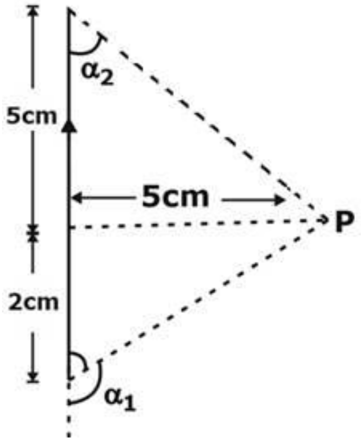
A. 8.86 A/m
B. 8.58 A/m
C. 6.54 A/m
D. 6.86 A/m

Answer ||| B

Solution |||

We know that

$$\bar{H} = \frac{I}{4\pi\rho}(\cos\alpha_2 - \cos\alpha_1)\, a_\rho$$



$\alpha_1 = 180^0 - \tan^{-1}\frac{5}{2}$ = 111.8°

$\alpha_2 = \tan^{-1}\frac{5}{5} = 45°$

So, $\bar{H} = \frac{5}{4\pi\times(0.05)}\left[\cos 45^0 - \cos 111.8^0\right]a_\rho$

$\bar{H} = 8.582\ A/m$

77.Consider the following statements:

1. In a charge free region, Maxwell equations can be reduced to two.

2. The reduced equations are of the form

$\nabla^2\overline{A} = \mu\sigma\frac{\partial\overline{A}}{dt} + \mu\varepsilon\frac{\partial^2\overline{A}}{dt^2}$

Where A can be $\bar{E}$ or $\bar{H}$

Which of the above statements is/are correct?

A. Only 1
B. Only 2
C. Both 1 and 2
D. Neither 1 nor 2

Answer ||| C

Solution |||

In a charge free region, the four Maxwell equations are reduced to two Helmholtz equation or wave equations.

$$\nabla^2 \bar{E} = \mu\sigma \frac{\partial \bar{E}}{\partial t} + \mu\varepsilon \frac{\partial^2 \bar{E}}{\partial t^2}$$

$$\nabla^2 \bar{H} = \mu\sigma \frac{\partial \bar{H}}{\partial t} + \mu\varepsilon \frac{\partial^2 \bar{H}}{\partial t^2}$$

78.Two charges are placed a a distance apart. Now, if a glass slab is inserted between them, then the force between the charges will

A. reduce to zero
B. increase
C. decrease
D. not charge

Answer ||| C

Solution |||
Force between charges

$$F = \frac{1}{4\pi \in_0} \frac{q_1 q_2}{r^2}$$ (in free space)

If glass slab is inserted between charges then

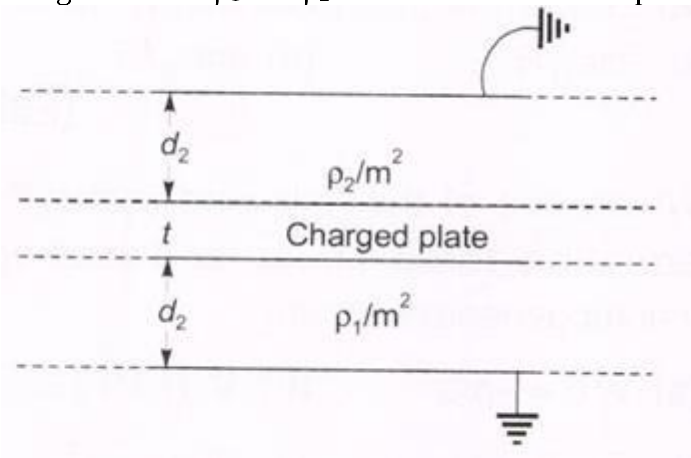
$$F = \frac{1}{4\pi \in_0 \in_r} \frac{q_1 q_2}{r^2}$$

$$F' = \frac{F}{\in_r}$$

as $\in_r \geq 1$

$\therefore$ force decreases

79.When an infinite charged conducting plate is placed between two infinite conducting grounded surfaces as shown in the figure given below, what would be the ratio of the surface charge densities ρ_1 and ρ_2 on the two sides of the plate?



A. $\frac{(d_1+t)}{(d_2+t)}$

B. $\frac{(d_2+t)}{(d_1+t)}$

C. $\frac{d_1}{d_2}$

D. $\frac{d_2}{d_1}$

Answer ||| C

Solution ||| Potential at both sides of conducting sheet will be same.

80.Which one of the following waveguide supports TM, TE, TEM waves?

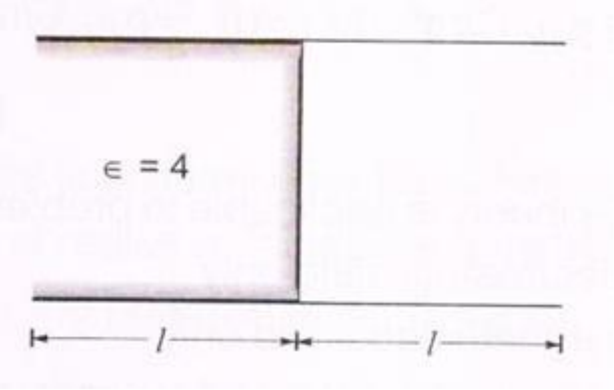
A. Rectangular waveguide
B. Circular waveguide
C. Parallel plate waveguide
D. Elliptical waveguide

Answer ||| C

Solution |||

Only the parallel plate waveguide supports TM, TE, TEM waves.

81.A parallel plate air capacitor carries a charge Q at its maximum withstand voltage V. If the capacitor is half filled with an insulating slab of dielectric constant 4 as shown in the figure given below, what are the maximum withstand voltage and the charge on the capacitor at this voltage, respectively?



A. 2.5 V, Q
B. 4V, 2.5 Q
C. V, 2.5 Q
D. V/4, Q

Answer ||| C

Solution ||| Two capacitors are connected is parallel so voltage rating will be same.
But net capacitance will be now

$$C_{eq} = C_1 + C_2$$

$$= \frac{\epsilon_0 \epsilon_r \ A'}{d} + \frac{\epsilon_0 \ A'}{d}$$

$$= \frac{4 \epsilon_0 \ A/2}{d} + \frac{\epsilon_0 \ A/2}{d}$$

$$= \frac{2 \epsilon_0 \ A}{d} + \frac{\epsilon_0 \ A}{2d} = 2 \cdot C + \frac{C}{2}$$

$\left(\because \frac{\epsilon_0 \ A}{d} = C \right)$ initial capacitance

$C_{eq} = 2.5$ C
Now new charge storage at withstand voltage V
Q' = C_{eq} V
Q' = 2.5 CV
Q' = 2.5 Q
(as Q = CV initially)

82.A 100-pF capacitor has a maximum charging current of 150 µA. What is the slew rate of capacitor?

A. 1.50 V/sec
B. 0.67 V/µsec
C. 0.67 V/sec
D. 1.50 V/µsec

Answer ||| D

Solution |||

$$C\frac{dv}{dt}=I$$
$$\left.\frac{dv}{dt}\right|_{max}=\frac{I_{max}}{C}$$
$$\left.\frac{dv}{dt}\right|_{max}=\frac{150\times10^{-6}}{100\times10^{-12}}=1.5\ V/\mu sec$$

83.For free space, intrinsic impedance in Ω is

A. $\sqrt{\mu_0\varepsilon_0}$
B. $\sqrt{\frac{\mu_0}{\varepsilon_0}}$
C. $\sqrt{\frac{\varepsilon_0}{\mu_0}}$
D. $i\sqrt{\mu_0\varepsilon_0}$

Answer ||| B

Solution |||

Intrinsic impedance $(\eta)=\sqrt{\frac{i\omega\mu}{\sigma+i\omega\varepsilon}}$

for free space, σ = 0

$\varepsilon_r=1$

$\mu_r = 1$

$$\eta = \sqrt{\frac{\mu_0}{\varepsilon_0}}$$

84.h = half centre to centre spacing, r = conductor radius and $\in$ = permittivity of the medium. Which one of the following is equal to the capacitance per unit length of a two-wire transmission line ?

A. $$\frac{\pi \in}{\log_e\left\{\left(\frac{h}{r}\right)+\left(\sqrt{\frac{h^2}{r^2}-1}\right)\right\}}$$

B. $$\frac{2\pi \in}{\log_e\left\{\left(\frac{h}{r}\right)+\left(\sqrt{\frac{h^2}{r^2}-1}\right)\right\}}$$

C. $$\frac{3\pi \in}{\log_e\left\{\left(\frac{h}{r}\right)+\left(\sqrt{\frac{h^2}{r^2}-1}\right)\right\}}$$

D. $$\frac{4\pi \in}{\log_e\left\{\left(\frac{h}{r}\right)+\left(\sqrt{\frac{h^2}{r^2}-1}\right)\right\}}$$

Answer ||| A

Solution ||| This is a standard formula for capacitance per unit length of a two wire transmission line

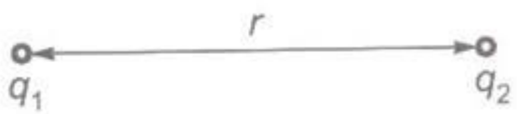
$$C = \frac{\pi \in}{\log_e\left\{\frac{h}{r}+\left(\sqrt{\left(\frac{h}{r}\right)^2-1}\right)\right\}}$$

where h $\rightarrow$ Half centre to centra spacing
r $\rightarrow$ Conductor radius
$\in \rightarrow$ Permittivity of the medium

85.Two charges are placed a a distance apart. Now, if a glass slab is inserted between them, then the force between the charges will

A. reduce to zero
B. increase
C. decrease
D. not change

Answer ||| C



Solution |||
Force between charges

$$F = \frac{1}{4\pi \in_0} \frac{q_1 q_2}{r^2}$$ (in free space)

If glass slab is inserted between charges then

$$F = \frac{1}{4\pi \in_0 \in_r} \frac{q_1 q_2}{r^2}$$

$$F' = \frac{F}{\in_r}$$

as $\in_r \geq 1$

$\therefore$ force decreases

86.**Statement (I):** The dielectric constant is the ratio of the permittivity of the dielectric to that of free space.

Statement (II): The dielectric strength is the maximum electric field that a dielectric, can tolerate or with stand without electrical breakdown.

A. Both statement (I) and statement (II) are true and statement (II) is correct explanation of statement (I)
B. Both statement (I) and statement (II) are true but statement (II) is not a correct explanation

of statement (I)
C. Statement (I) is true but statement (II) is false
D. Statement (I) is false but statement (II) is true

Answer ||| B

Solution |||

Both statement (I) and statement (II) are true but statement (II) is not a correct explanation of statement (I)

87.The mathematical analogous of the gradient is said to be

A. Arc
B. Slope
C. Tangent
D. Chord

Answer ||| B

Solution |||

The gradient is defined as the rate of change of function which is analogous to slope.

88.Which of the following is not Maxwell equation

A. $\nabla . D = \rho V$
B. $\nabla \times E = 0$
C. $\nabla \times H = J$
D. $\nabla . J = \frac{-\partial \rho v}{\partial t}$

Answer ||| D

Solution |||

$$\text{maxwell equatin}\begin{cases}\nabla.D = \rho_V \longrightarrow \text{Gauss's law} \\ \nabla \times E = 0 \longrightarrow \text{Conservation of electric field} \\ \nabla \times H = J \longrightarrow \text{Ampere ckt Law} \\ \nabla.B = 0 \longrightarrow \text{Single magnet pole can not exist i.e} \\ \qquad\qquad \text{conservation of magnetic flux}\end{cases}$$

$\Rightarrow$ $\nabla.J = \frac{-\partial \rho_V}{\partial t}$ is continuity equation

89.In a waveguide evanescent modes are said to occur if

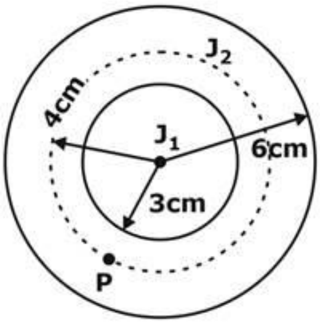
A. the propagation constant is imaginary
B. the propagation constant is real
C. Only TEM wave propagates
D. None

Answer ||| B

Solution |||

Evanescent modes propagate when the propagation constant is real.

90.The magnitude of magnetic field intensity at point P (r = 4) is



If $J_1 = \frac{2}{\pi} A/m^2 \quad \& \; r_1 = 3 \text{ cm}$

$J_2 = \frac{0.5}{\pi} A/m^2 \quad \& \; r_2 = 6 \text{ cm}$

A. 8.55 mA/m
B. 7.55 mA/m

C. 8.95 mA/m
D. 9.55 mA/m

Answer ||| A

Solution |||

Apply Ampere circuit law

$\int H.dl = I_{enclosed}$

$H \times 2\pi(0.04) = I_{enclosed}$

$I_{enclosed} = J_1 \times \pi(r_1)^2 + J_2 \times \pi(r^2 - r_1^2)$

$= \frac{2}{\pi} \times \pi(0.03)^2 + \frac{0.5}{\pi} \times \pi(0.04^2 - 0.03^2)$ = 0.00215 Amp

$H = \frac{0.00215}{2\pi \times 0.04} = 8.55\ mA/m$

91.The capacitance of an insulated conducting sphere of radius R in vacuum is

A. $2\pi\varepsilon_0 R$
B. $4\pi\varepsilon_0 R$
C. $4\pi\varepsilon_0 R^2$
D. $4\pi\varepsilon_0 lR$

Answer ||| B

Solution ||| Suppose there is charge Q is placed on conducting sphere. Due to conductivity of sphere this charge will be uniformly distributed on the sphere.
So potential at the surface of such sphere is

$$V = \frac{Q}{4\pi \in_0 R}$$ for r ≤ r

$$\therefore C = \frac{Q}{V}$$

$$[C = 4\pi \in_0 R]$$

92.Which one of the following is the Poisson's equation for a linear and isotropic but inhomogeneous medium?

A. $\nabla^2 E = -\rho / \in$

B. $\bar{\nabla} \cdot (\in \bar{\nabla} V) = -\rho$

C. $\bar{\nabla} \cdot \bar{\nabla}(\in V) = -\rho$

D. $\nabla^2 V = -\rho / \in$

Answer ||| B

Solution ||| We known that,

$$\nabla \cdot \vec{D} = \rho_V$$

but $D = \in \vec{E}$

$$\therefore \nabla \cdot (\in \vec{E}) = \rho_V$$

But $\vec{E} = -\nabla V'$

V-potential (Scalar)

$$\nabla \cdot (-\in \nabla V) = \rho_V$$

$$[\nabla \cdot (\in \nabla V) = -\rho_V]$$

Medium is inhomogeneous i.e. $\in$ is function of dimensions x, y, z so we can't take it outside.

93.Two identical coaxial circular loops carry the same current circulating in the same direction. If the loops approached each other, then the current in

A. Each one of them will increase
B. Both of them will remain the same
C. Each one of them will decrease
D. One will increase while in the other the current will decrease

Answer ||| A

Solution ||| Suppose, 2 identical circular loops carry the same current circulating in clockwise direction, when seen from up side. In this case the lower front of upper loop will behave like north pole and upper front of lower loop will behave like south pole i.e. there will be attraction between the loops and hence these will support the current flowing in each other. So, the current in each of them will increase.

94.For static field, continuity equation is

A. ∇. J = 0
B. $\nabla . \bar{J} = 0$
C. ∇ × J = 0
D. $\nabla \times \bar{J} = 0$

Answer ||| B

Solution |||

Continuity equation, $\nabla . \bar{J} = -\frac{\partial \rho_v}{\partial t}$

For static field, $\frac{\partial \rho_v}{\partial t} = 0$

So, for static field, $\nabla . \bar{J} = 0$.

95.If displacement flux density, $\vec{D} = 3xy\ \hat{a}_x + 2yz\ \hat{a}_y + 5xz\ \hat{a}_z\ C/m^2$, then find the value of displacement flux crossing the plane y = 5 for 0 ≤ x ≤ 3, 0 ≤ z ≤ 4

A. 120 C
B. 160 C
C. 240 C
D. 320 C

Answer ||| C

Solution |||

Given, $\vec{D} = 3xy\,\hat{a}_x + 2yz\,\hat{a}_y + 5xz\,\hat{a}_z\ C/m^2$

Displacement flux, $\psi = \int\int \vec{D}\cdot\overrightarrow{ds}$

$$\psi = \int_{z=0}^{4}\int_{x=0}^{3}\left(3xy\,\hat{a}_x + 2yz\,\hat{a}_y + 5xz\,\hat{a}_z\right)\cdot dx\,dz\,\hat{a}_y$$

$$\Rightarrow\quad \psi = \int_{z=0}^{4}\int_{x=0}^{3}(2yz)\,dx\,dz$$

y = 5 plane

$$\Rightarrow\quad \psi = \int_{z=0}^{4}\int_{x=0}^{3}10z\,dx\,dz$$

$$10\left[\frac{z^2}{2}\right]_0^4\left[x\right]_0^3$$

$$= 10\times\frac{4^2}{2}\times 3$$

= 240 C

96.A charged particle is moving with uniform $10\,\hat{i}$ m/sec velocity in $\vec{E} = 40\hat{i}$ V/m field and $\vec{B} = B_0\hat{k}$ Wb/m^2 field (coexisting fields).

What should be the value of B_0, so that particle velocity remains constant.

A. 2
B. 4
C. 8
D. 16

Answer ||| B

Solution |||

Particle velocity = constant

So, Acceleration = 0

or force = 0 on particle

F = Q $\left(\bar{E} + \bar{v} \times \bar{B}\right)$

or $40\hat{j} + 10i \times B_0 k = 0$

$40\hat{i} - 10B_0\hat{i} = 0$

or B_0 = 4 Wb/m^2

97.The phasor representation of ß(y,t) = āB_0cos(ώt – βy) is:

A. B = $ă_x$ $B_0e^{-j\beta y}$
B. B = $ă_x$ $B_0e^{j\beta y}$
C. B = $ă_x$ $B_0e^{\beta y}$
D. B = $ă_x$ /$B_0e^{-j\beta y}$

Answer ||| A

Solution ||| We can solve the vector components in steady state along (y, t) and by taking the cos value of the expression, we get
B (y, t) = $ă_x$ B_0 cos (ωt – βy)
Also, B (t) = Re [$ă_x$ $B_0e^{j(\omega t - \beta y)}$]
= $ă_x$ Re [$B_0e^{j\beta y}$ $e^{j\omega t}$]
= $ă_x$ $B_0e^{-j\beta y}$

98.Transverse Electromagnetic waves are characterized by

A. During wave propagation in Z- direction the components of H and E are transverse 60^0 to the direction of propagation of the waves.
B. During wave propagation in Z- direction, the component of H and E are transverse to the dirtection of propagation of the waves.
C. During wave propagation in Z- direction, the componenets of H and E are transverse 120^0 to the direction of propagation of the waves
D. None of the above

Answer ||| B

Solution ||| $\overrightarrow{H}, \overrightarrow{E}$ and direction of propagation of electromagnetic wave , these all 3 are perpendicular to each other.

99.A dielectric material is placed in vacuum in a uniform electric field of E = 10 V/m. What is the electric field inside the material if the relative permittivity of dielectric material is 2?

A. zero
B. 4 V/m
C. 2 V/m
D. 5 V/m

Answer ||| D

Solution |||

$$E \propto \frac{1}{\varepsilon} or E \propto \frac{1}{\varepsilon_0 \varepsilon_r}$$

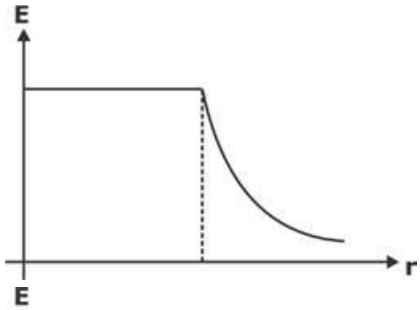
$$E \propto \frac{1}{\varepsilon_r}$$

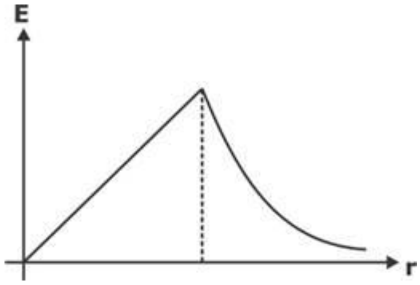
$$\frac{E_1}{E_2} = \frac{Er_2}{Er_1} = \frac{2}{1} = \frac{10}{E_2}$$

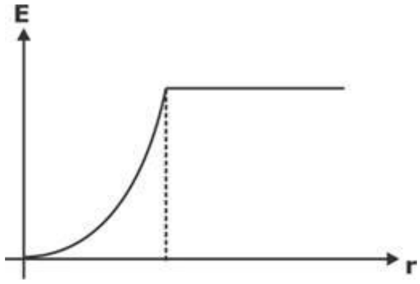
E_2 = 5 V/m

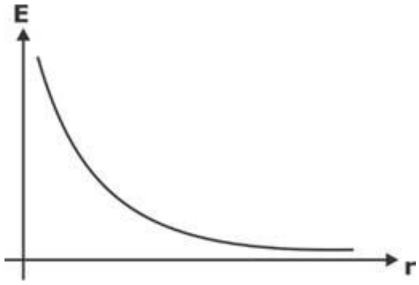
∴ Relative permittivity of vacuum is 1.

100.Which of the following curves represent the electric field due to an infinitely long straight conductor?

A. 

B. 

C. 

D. 

Answer ||| D

Solution |||

Electric field due to an infinitely long straight conductor is given by,

$$E = \frac{\lambda}{2\pi\varepsilon_0 r}$$

Where λ is the linear charge density and r is the radius of the cylinder.

$$\Rightarrow E \propto \frac{1}{r},$$

Hence, option (D) is correct.