Practice Set-1

1. The x - and z-components of a static magnetic field in a region are $B_x = B_0\left(x^2 - y^2\right)$ and $B_z = 0$, respectively. Which of the following solutions for its y-component is consistent with the Maxwell equations?
[NET/JRF-(JUNE-2016)]

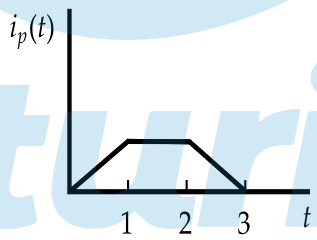
a. $B_y = B_0 xy$
b. $B_y = -2B_0 xy$
c. $B_y = -B_0\left(x^2 - y^2\right)$
d. $B_y = B_0\left(\frac{1}{3}x^3 - xy^2\right)$

Solution:

$$B_x = B_0\left(x^2 - y^2\right), B_z = 0$$
$$\because \vec{\nabla} \cdot \vec{B} = 0 \Rightarrow \frac{\partial B_x}{\partial x} + \frac{\partial B_y}{\partial y} + \frac{\partial B_z}{\partial z} = 0 \Rightarrow \frac{\partial B_y}{\partial y}$$
$$= -\frac{\partial B_x}{\partial x} = -2B_0 x \Rightarrow B_y = -2B_0 xy$$

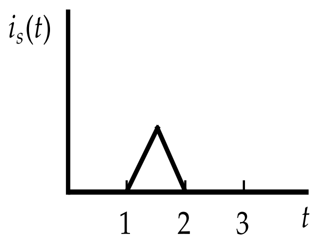
So the correct answer is **Option (b)**

2. A current i_p flows through the primary coil of a transformer. The graph of $i_p(t)$ as a function of time t is shown in the figure below.

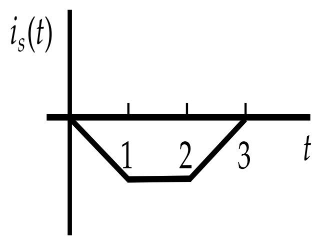


Which of the following graphs represents the current i_S in the secondary coil?
[NET/JRF(JUNE-2014)]

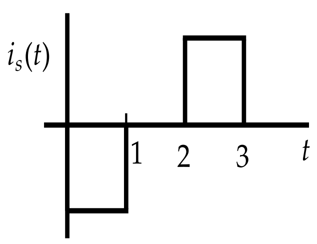
a.



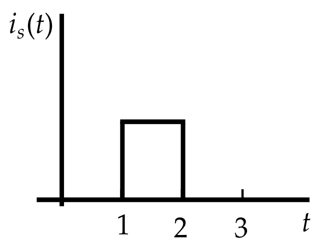
b.



c.



d.

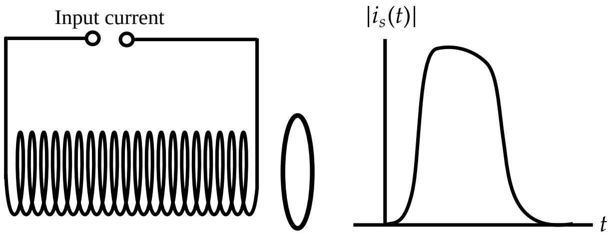


Solution:

$$i_s \propto -\frac{di_p}{dt}$$

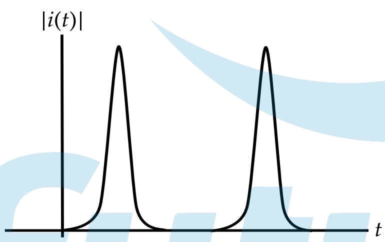
So the correct answer is **Option (c)**

3. A circular conducting wire loop is placed close to a solenoid as shown in the figure bellow. Also shown is the current through the solenoid as a function of solenoid as a function of time.

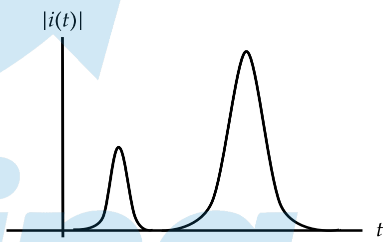


The magnitude $|i(t)|$ of the induced current in the wire loop, as a function of time t, is best represented as.
[NET/JRF(DEC-2019)]

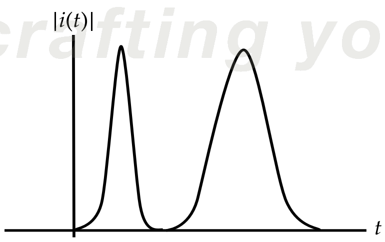
a.



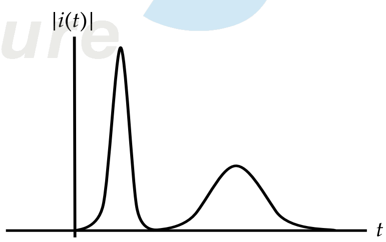
b.



c.



d.



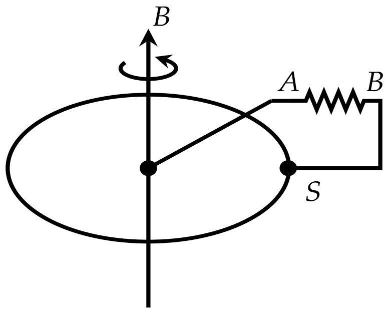
Solution:

$$\text{Induced e.m.f } \varepsilon = -\frac{d\phi}{dt}, \quad |I(t)| = \frac{|\varepsilon|}{R} \propto \left|\frac{dIs}{dt}\right|$$

So when current increases,$|I(t)|$ will increase and when it will decrease $|I(t)|$ will decrease.

So the correct answer is **Option (d)**

4. A horizontal metal disc rotates about the vertical axis in a uniform magnetic field pointing up as shown in the figure. A circuit is made by connecting one end A of a resistor to the centre of the disc and the other end B to its edge through a sliding contact. The current that flows through the resistor is
[NET/JRF(DEC-2013)]

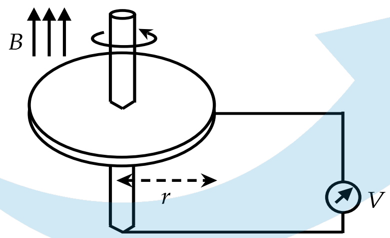


a. Zero **b.** *DC* from *A* to *B* **c.** *DC* from *B* to *A* **d.** *AC*,

Solution: So the correct answer is **Option (b)**

5. A conducting circular disc of radius r and resistivity ρ rotates with an angular velocity ω in a magnetic field B perpendicular to it. A voltmeter is connected as shown in the figure below. Assuming its internal resistance to be infinite, the reading on the voltmeter

[NET/JRF(DEC-2016)]



a. Depends on ω, B, r and ρ

b. Depends on ω, B and r but not on ρ

c. Is zero because the flux through the loop is not changing

d. Is zero because a current the flows in the direction of B

Solution:

Force experienced by charge is

$$\vec{F} = q(\vec{v} \times \vec{B}) \text{ and } v = r\omega$$

So the correct answer is **Option (b)**

6. A uniform magnetic field in the positive z-direction passes through a circular wire loop of radius 1 cm and resistance 1Ω lying in the xy-plane. The field strength is reduced from 10 tesla to 9 tesla in $1s$. The charge transferred across any point in the wire is approximately

[NET/JRF-(JUNE-2015)]

a. 3.1×10^{-4} coulomb **b.** 3.4×10^{-4} coulomb

c. 4.2×10^{-4} coulomb **d.** 5.2×10^{-4} coulomb

Solution:

$$\varepsilon = -\frac{d\phi}{dt} \Rightarrow I = \frac{dq}{dt} = \frac{\varepsilon}{R}$$
$$= -\frac{1}{R}\frac{d\phi}{dt} \Rightarrow dq = -\frac{A}{R}dB = \frac{-\pi r^2}{R}dB$$

$$\Rightarrow dq = \frac{-3.14 \times \left(10^{-2}\right)^2}{1} \times 1 = 3.14 \times 10^{-4} \text{ coulomb}$$

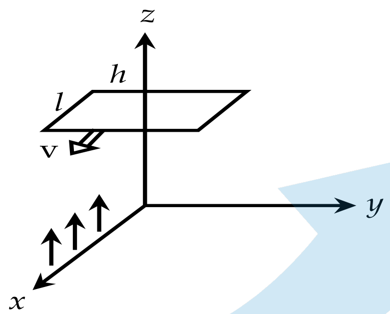
So the correct answer is **Option (a)**

7. A magnetic field B is $B\hat{z}$ in the region $x > 0$ and zero elsewhere. A rectangular loop, in the xy-plane, of sides l (along the x-direction) and h (along the y-direction) is inserted into the $x > 0$ region from the $x < 0$ region at constant velocity $v = v\hat{x}$. Which of the following values of l and h will generate the largest EMF? **[NET/JRF-(JUNE-2016)]**

a. $l = 8, h = 3$ **b.** $l = 4, h = 6$

c. $l = 6, h = 4$ **d.** $l = 12, h = 2$

Solution:



$$\phi_m \propto Bhx$$

$$\varepsilon \propto \frac{-d\phi_m}{dt} \propto Bvh \propto h$$

So the correct answer is **Option (b)**

8. Consider a solenoid of radius R with n turns per unit length, in which a time dependent current $I = I_0 \sin\omega t$ (where $\omega R/c << 1$) flows. The magnitude of the electric field at a perpendicular distance $r < R$ from the axis of symmetry of the solenoid, is

[NET/JRF-(DEC-2011)]

a. 0 **b.** $\frac{1}{2r}\omega\mu_0 n I_0 R^2 \cos\omega t$

c. $\frac{1}{2}\omega\mu_0 n I_0 r \sin\omega t$ **d.** $\frac{1}{2}\omega\mu_0 n I_0 r \cos\omega t$

Solution:

$$\oint \vec{E} \cdot d\vec{l} = -\int \frac{\partial \vec{B}}{\partial t} \cdot d\vec{a}; \quad \left(\vec{B} = \mu_0 n I(t) \hat{z}\right)$$

$$\Rightarrow |\vec{E}| \times 2\pi r = -\mu_0 n \frac{dI}{dt} \int_{r'=0}^{r} 2\pi r' dr'$$

$$= -\mu_0 n \times I_0 \omega \cos\omega t \times \frac{2\pi r^2}{2}$$

$$\Rightarrow |\vec{E}| = -\frac{1}{2} \times \omega\mu_0 n I_0 r \cos\omega t$$

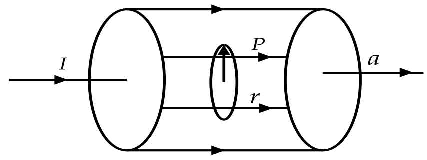
So the correct answer is **Option (d)**

9. A parallel plate capacitor is formed by two circular conducting plates of radius a separated by a distance d, where $d \ll a$. It is being slowly charged by a current that is nearly constant. At an instant when the

current is I, the magnetic induction between the plates at a distance $\frac{a}{2}$ from the centre of the plate, is
[NET/JRF-(DEC-2016)]

a. $\frac{\mu_0 I}{\pi a}$ **b.** $\frac{\mu_0 I}{2\pi a}$ **c.** $\frac{\mu_0 I}{a}$ **d.** $\frac{\mu_0 I}{4\pi a}$

Solution:



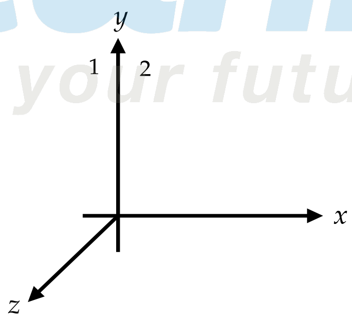
$$|\vec{B}| = \frac{\mu_0 I r}{2\pi a^2}$$
$$|\vec{B}| = \frac{\mu_0 I}{4\pi a} \text{ at } r = \frac{a}{2}$$

So the correct answer is **Option (d)**

10. Suppose the yz-plane forms a chargeless boundary between two media of permittivities $\varepsilon_{\text{left}}$ and $\varepsilon_{\text{right}}$ where $\varepsilon_{\text{left}} : \varepsilon_{\text{right}} = 1 : 2$, if the uniform electric field on the left is $\vec{E}_{\text{left}} = c(\hat{i}+\hat{j}+\hat{k})$ (where c is a constant), then the electric field on the right $\vec{E}_{\text{right}}$ is
[NET/JRF(JUNE-2015)]

a. $c(2\hat{i}+\hat{j}+\hat{k})$ **b.** $c(\hat{i}+2\hat{j}+2\hat{k})$ **c.** $c\left(\frac{1}{2}\hat{i}+\hat{j}+\hat{k}\right)$ **d.** $c\left(\hat{i}+\frac{1}{2}\hat{j}+\frac{1}{2}\hat{k}\right)$

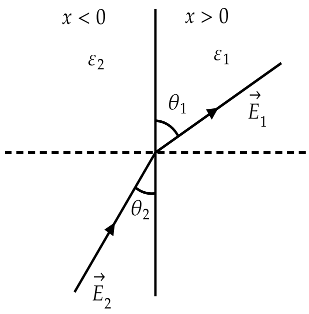
Solution:



$$E_1^{\prime\prime} = c(\hat{j}+\hat{k}) = E_2^{\prime\prime}$$
$$D_1^{\perp} = D_2^{\perp} \Rightarrow \varepsilon_1 E_1^{\perp} = \varepsilon_2 E_2^{\perp} \Rightarrow E_2^{1} = \frac{\varepsilon_1}{\varepsilon_2} E_1^{\perp}$$
$$\Rightarrow E_2^{\perp} = \frac{1}{2} c\hat{i} \Rightarrow \vec{E}_2 = c\left(\frac{1}{2}\hat{i}+\hat{j}+\hat{k}\right)$$

So the correct answer is **Option (c)**

11. The half space region $x > 0$ and $x < 0$ are filled with dielectric media of dielectric constants ε_1 and ε_2 respectively. There is a uniform electric field in each part. In the right half, the electric field makes an angle θ_1 to the interface. The corresponding angle θ_2 in the left half satisfies
[NET/JRF(JUNE-2016)]



a. $\varepsilon_1 \sin\theta_2 = \varepsilon_2 \sin\theta_1$

b. $\varepsilon_1 \tan\theta_2 = \varepsilon_2 \tan\theta_1$

c. $\varepsilon_1 \tan\theta_1 = \varepsilon_2 \tan\theta_2$

d. $\varepsilon_1 \sin\theta_1 = \varepsilon_2 \sin\theta_2$

Solution:

$$\frac{\tan\theta_1}{\tan\theta_2} = \frac{\frac{E_1^{\perp}}{E_1^{\parallel}}}{\frac{E_2^{\perp}}{E_2^{\parallel}}} = \frac{E_1^{\perp}}{E_2^{\perp}} \quad \left(\because E_1^{\parallel} = E_2^{\parallel}\right)$$

$$D_1^{\perp} = D_2^{\perp} \Rightarrow \varepsilon_1 E_1^{\perp} = \varepsilon_2 E_2^{\perp} \Rightarrow \frac{E_1^{\perp}}{E_2^{\perp}} = \frac{\varepsilon_2}{\varepsilon_1} \Rightarrow \frac{\tan\theta_1}{\tan\theta_2}$$

$$= \frac{\varepsilon_2}{\varepsilon_1} \Rightarrow \varepsilon_1 \tan\theta_1 = \varepsilon_2 \tan\theta_2$$

So the correct answer is **Option (c)**

12. Which of the following is not a correct boundary condition at an interface between two homogeneous dielectric media? (In the following $\hat{n}$is a unit vector normal to the interface, σ and $\vec{j}_s$, are the surface charge and current densities, respectively.)

[NET/JRF(JUNE-2019)]

a. $\hat{n} \times \left(\vec{D}_1 - \vec{D}_2\right) = 0$

b. $\hat{n} \times \left(\vec{H}_1 - \vec{H}_2\right) = \vec{j}_s$

c. $\hat{n} \cdot \left(\vec{D}_1 - \vec{D}_2\right) = \sigma$

d. $\hat{n} \cdot \left(\vec{B}_1 - \vec{B}_2\right) = 0$

Solution:

Since media is homogeneous dielectric: assume uniform polarisation and magnetisation.

σ and $\vec{j}_s$, are the free surface charge and free surface current densities.

$$\vec{\nabla} \times \vec{D} = 0 \quad \Rightarrow D_1^{\parallel} = D_2^{\parallel}$$

$$\because \vec{\nabla} \times \vec{P} = 0 \quad \text{and} \quad D_1^{\perp} - D_2^{\perp} = \sigma$$

$$\text{Thus } \left(\vec{D}_1 - \vec{D}_2\right) = \sigma\hat{n}$$

$$\Rightarrow \hat{n} \cdot \left(\vec{D}_1 - \vec{D}_2\right) = \sigma \quad \text{and } \hat{n} \times \left(\vec{D}_1 - \vec{D}_2\right) \neq 0$$

$$\vec{\nabla} \cdot \vec{H} = -\vec{\nabla} \cdot \vec{M} = 0 \quad \Rightarrow H_1^{\perp} = H_2^{\perp}$$

$$\because \vec{\nabla} \cdot \vec{M} = 0 \quad \text{and} \quad H_1^{\parallel} - H_2^{\parallel} = j_s$$

$$\text{Thus } \left(\vec{H}_1 - \vec{H}_2\right) = \vec{j}_s \times \hat{n}$$

$$\Rightarrow \hat{n} \times \left(\vec{H}_1 - \vec{H}_2\right) = \vec{j}_s$$

Also

$\vec{\nabla} \cdot \vec{B} = 0 \quad \Rightarrow B_1^{\perp} = B_2^{\perp}$ and $B_1^{\parallel} - B_1^{\parallel} = \mu_0 K$ (assume K is total surface current at interface)

$$\text{Thus } \left(\vec{B}_1 - \vec{B}_2\right) = \mu_0(\vec{K} \times \hat{n}).$$

$$\Rightarrow \hat{n} \cdot \left(\vec{B}_1 - \vec{B}_2\right) = 0$$

So the correct answer is **Option (a)**

Answer key			
Q.No.	Answer	Q.No.	Answer
1	**b**	2	**c**
3	**d**	4	**c**
5	**b**	6	**a**
7	**b**	8	**d**
9	**d**	10	**c**
11	**c**	12	**a**

Practice Set-2

1. Two rails of a railroad track are insulated from each other and from the ground, and are connected by a millivoltmeter. What is the reading of the millivoltmeter when a train travels at the speed 90 km/hr down the track? Assume that the vertical component of the earth's magnetic field is 0.2 gauss and that the tracks are separated by two meters. Use 1 gauss $= 10^{-4}$ Tesla $= 10^{-4}$ V $\cdot$ sec/m^2

[JEST-2020]

a. 10 **b.** 1 **c.** 0.2 **d.** 180

Solution:

$$\text{Magnetic flux } \phi_m = Blx \Rightarrow \text{ e.m.f } \varepsilon = -\frac{d\phi_m}{dt} = -Blv$$

$$\Rightarrow |\varepsilon| = 0.2\times 10^{-4}\times 2m\times \frac{90\times 10^3}{3600} \text{ Volts } \Rightarrow |\varepsilon| = 1\text{mV}$$

So the correct answer is **Option (b)**

2. Which of the following expressions represents an electric field due to a time varying magnetic field?

[JEST-2015]

a. $K(x\hat{x}+y\hat{y}+z\hat{z})$ **b.** $K(x\hat{x}+y\hat{y}-z\hat{z})$

c. $K(x\hat{x}-y\hat{y})$ **d.** $K(y\hat{y}-x\hat{y}+2z\hat{z})$

Solution:

$$\vec{B}\neq\vec{\nabla}\times\vec{A}$$

So the correct answer is **Option (c)**

3. Two parallel rails of a railroad track are insulated from each other and from the ground. The distance between the rails is 1 meter. A voltmeter is electrically connected between the rails. Assume the vertical component of the earth's magnetic field to the 0.2 gauss. What is the voltage developed between the rails when a train travels at a speed of 180 km/h along the track? Give the answer in milli-volts.

[JEST-2018]

Solution:

$$\text{Induced emf } \varepsilon = Blv = \left(0.2\times 10^{-4}\right)\times 1 \text{ m}\times 180\times\frac{10}{60\times 60} = 10^{-3} \text{ volts } = 1\text{mV}$$

So the correct answer is **1.0**

4. A very long solenoid (axis along z direction) of n turns per unit length carries a current which increases linearly with time, $i = Kt$. What is the magnetic field inside the solenoid at a given time t ?

[JEST-2019]

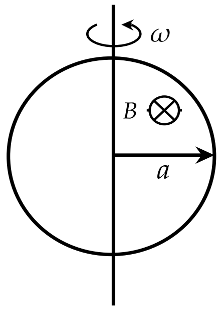
a. $\vec{B} = \mu_0 nKt\hat{z}$ **b.** $\vec{B} = \mu_0 nK\hat{z}$

c. $\vec{B} = \mu_0 nKt(\hat{x}+\hat{y})$ **d.** $\vec{B} = \mu_0 cnKt\hat{z}$

Solution: So the correct answer is **Option (a)**

5. A circular metal loop of radius $a = 1$ m spins with a constant angular velocity $\omega = 20\pi \text{rad/s}$ in a magnetic field $B = 3$ Tesla, as shown in the figure. The resistance of the loop is 10 ohms. Let P be the power dissipated in one complete cycle. What is the value of $\frac{P}{\pi^4}$ in Watts?

[JEST-2019]



Solution:

$$\text{Magnetic flux through the loop is } \phi_m = \int_S \vec{B}d\vec{a} = B \times \pi a^2 \times \cos\omega t$$

$$\text{Induced e.m.f } \varepsilon = -\frac{d\phi_m}{dt} = \omega B \times \pi a^2 \times \sin\omega t$$

$$Powerdissipated p = \frac{\varepsilon^2}{R} = \frac{\omega^2 B^2 \pi^2 a^4 \sin^2\omega t}{R}$$

$$\text{Power dissipated in one complete cycle } P = \langle p \rangle = \frac{\omega^2 B^2 \pi^2 a^4}{2R} \because \langle \sin^2\omega t \rangle = \frac{1}{2}$$

$$\frac{P}{\pi^4} = \frac{\omega^2 B^2 a^4}{2\pi^2 R} \Rightarrow P = \frac{(20\pi)^2 (3)^2 (1)^4}{2(10)(10)} = 18$$

So the correct answer is **18**

6. Self inductance per unit length of a long solenoid of radius R with n turns per unit length is:

[JEST-2016]

a. $\mu_0 \pi R^2 n^2$ **b.** $2\mu_0 \pi R^2 n$ **c.** $2\mu_0 \pi R^2 n^2$ **d.** $\mu_0 \pi R^2 n$

Solution: So the correct answer is **Option (a)**

7. The $x - y$ plane is the boundary between free space and a magnetic material with relative permeability μ_r. The magnetic field in the free space is $B_x\hat{i} + B_z\hat{k}$. The magnetic field in the magnetic material is

[GATE- 2016]

a. $B_x\hat{i} + B_z\hat{k}$ **b.** $B_x\hat{i} + \mu_r B_z\hat{k}$

c. $\frac{1}{\mu_r} B_x\hat{i} + B_z\hat{k}$ **d.** $\mu_r B_x\hat{i} + B_z\hat{k}$

Solution:

$$B_1^{\perp} = B_z\hat{k} = B_2^{\perp} \text{ and } H_1^{\|} =$$

$$H_2^{\|} \Rightarrow \frac{B_1^{\|}}{\mu_0} = \frac{B_2^{\|}}{\mu_0 \mu_r} \Rightarrow B_2^{\|}$$

$$= \mu_r B_1^{\|} = \mu_r B\hat{i}$$

The magnetic field in the magnetic material is $\mu_r B_x \hat{i} + B_z \hat{k}$

So the correct answer is **Option (d)**

8. At a surface current, which one of the magnetostatic boundary condition is NOT CORRECT?
[GATE- 2013]

   a. Normal component of the magnetic field is continuous.

   b. Normal component of the magnetic vector potential is continuous.

   c. Tangential component of the magnetic vector potential is continuous.

   d. Tangential component of the magnetic vector potential is not continuous.

Solution: So the correct answer is **Option (d)**

9. A circular loop made of a thin wire has radius 2 cm and resistance 2Ω. It is placed perpendicular to a uniform magnetic field of magnitude $\left|\vec{B}_0\right| = 0.01$ Tesla. At time $t = 0$ the field starts decaying as $\vec{B} = \vec{B}_0 e^{-t/t_0}$, where $t_0 = 1s$. The total charge that passes through a cross section of the wire during the decay is Q. The value of Q in μC (rounded off to two decimal places) is
[GATE- 2019]

Solution:

$$
\begin{aligned}
\varepsilon &= -\frac{d\phi}{dt} = -\frac{AdB}{dt}, I \\
&= \frac{\varepsilon}{R} = -\frac{d\phi}{dt}\frac{1}{R} \\
\Rightarrow -\frac{d\phi}{dt} &= -\pi r^2 \frac{d}{dt}\left(B_0 e^{-t/t_0}\right) \\
&= \pi r^2 B_0 e^{-t}\,(t_0 = 1) \\
Q &= \int_0^{\infty} I(t)dt = \int_0^{\infty} \frac{\pi r^2}{R} B_0 e^{-t} dt \\
&= \frac{\pi r^2 B_0}{R}\left|\frac{e^{-t}}{-1}\right|_0^{\infty} \\
&= 3.14 \times \left(2 \times 10^{-2}\right)^2 \times 0.01 \\
&= 6.28\mu C
\end{aligned}
$$

10. A long solenoid is embedded in a conducting medium and is insulated from the medium. If the current through the solenoid is increased at a constant rate, the induced current in the medium as a function of the radial distance r from the axis of the solenoid is proportional to
[GATE- 2015]

   a. r^2 inside the solenoid and $\frac{1}{r}$ outside

   b. r inside the solenoid and $\frac{1}{r^2}$ outside

   c. r^2 inside the solenoid and $\frac{1}{r^2}$ outside

   d. r inside the solenoid and $\frac{1}{r}$ outside

Solution:

$$\oint \vec{E}\cdot d\vec{l} = -\int \frac{\partial \vec{B}}{\partial t}\cdot d\vec{a}$$

$$\text{For } r<R, |\vec{E}|2\pi r = -\mu_0 n\frac{dI}{dt}\int_{r'=0}^{r} 2\pi r' dr'$$

$$= -\mu_0 n \frac{dI}{dt}\frac{2\pi r^2}{2} \Rightarrow |\vec{E}|$$

$$= -\frac{1}{2}\mu_0 n\frac{dI}{dt}r$$

$$\text{For } r>R, |\vec{E}|2\pi r = -\mu_0 n\frac{dI}{dt}\int_{r'=0}^{R} 2\pi r' dr'$$

$$= -\mu_0 n \frac{dI}{dt}\frac{2\pi R^2}{2} \Rightarrow |\vec{E}|$$

$$= -\frac{1}{2r}\mu_0 n\frac{dI}{dt}R^2$$

11. Consider an infinitely long solenoid with N turns per unit length, radius R and carrying a current $I(t) = \alpha\cos\omega t$, where α is a constant and ω is the angular frequency. The magnitude of electric field at the surface of the solenoid is

a. $\frac{1}{2}\mu_0 NR\omega\alpha\sin\omega t$

b. $\frac{1}{2}\mu_0\omega NR\cos\omega t$

c. $\mu_0 NR\omega\alpha\sin\omega t$

d. $\mu_0\omega NR\cos\omega t$

Solution:

$$\vec{B} = \begin{cases} \mu_0 NI(t)\hat{z}, & \text{inside} \\ 0 & \text{, outside} \end{cases}$$

$$\text{Since, } \oint_{\text{line}} \vec{E}\cdot d\vec{l} = -\int \frac{\partial \vec{B}}{\partial t}\cdot d\vec{a}$$

$$\Rightarrow |\vec{E}|\times 2\pi R = -\mu_0 N(-\alpha\omega\sin\omega t)\times \pi R^2$$

$$\Rightarrow |\vec{E}| = \frac{1}{2}\mu_0 NR\omega\alpha\sin\omega t$$

So the correct answer is **Option (a)**

12. A medium $(\varepsilon_r > 1, \mu_r = 1, \sigma > 0)$ is semi-transparent to an electromagnetic wave when

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a. Conduction current $\gg>$ Displacement current

b. Conduction current $<<$ Displacement current

c. Conduction current $=$ Displacement current

d. Both Conduction current and Displacement current are zero

Solution:

$$\text{Conduction current } J_c = \sigma E = \sigma E_0 \cos\omega t$$

$$\text{Displacement current } J_d = \varepsilon\frac{\partial E}{\partial t} \Rightarrow |J_d| = \omega\varepsilon E_0\sin\omega t$$

For semi-transparent medium i.e for poor conductor $\sigma << \omega\varepsilon$.

$$\text{Let } \omega t = \frac{\pi}{4} \Rightarrow \frac{J_c}{J_d} = \frac{\sigma E_0}{\omega\varepsilon E_0} = \frac{\sigma}{\omega\varepsilon} << 1 \Rightarrow J_c << J_d$$

So the correct answer is **Option (b)**

13. A sinusoidal voltage of the form $V(t) = V_0\cos(\omega t)$ is applied across a parallel plate capacitor placed in vacuum. Ignoring the edge effects, the induced emf within the region between the capacitor plates can be expressed as a power series in ω. The lowest nonvanishing exponent in ω is ———

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Solution:

$$\text{Induced e.m.f } \varepsilon = -\frac{d\phi}{dt} = -\frac{AdB}{dt}$$

$$\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{\text{enc}} + \mu_0\varepsilon_0 \int_S \frac{\partial \vec{E}}{\partial t}\cdot d\vec{a}$$

Consider an amperian loop of radius $r(r < R)$, then $I_{enc} = 0$ and since

$$E(t) = \frac{V(t)}{d} = \frac{V_0\cos\omega t}{d}$$

$$\text{Thus } |\vec{B}| \times 2\pi r = \mu_0\varepsilon_0 \times \left(-\frac{V_0\omega\sin\omega t}{d}\right) \times \pi r^2 \Rightarrow |\vec{B}| \propto \omega\sin\omega t$$

$$\Rightarrow \varepsilon \propto \frac{dB}{dt} \propto \omega^2\cos\omega t \propto \omega^2\left(1 - \frac{\omega^2 t^2}{2} + \ldots\right)$$

The lowest non-vanishing exponent in ω is $n = 2$.

So the correct answer is **2**

Answer key

Q.No.	Answer	Q.No.	Answer
1	**b**	2	**d**
3	**1.0**	4	**a**
5	**18**	6	**a**
7	**d**	8	**d**
9	**6.28**	10	**d**
11	**a**	12	**b**
13	**2**	14	