

PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

CSIR NET Physics - Electromagnetism

All PYQs (2015-2025) with answer key

126 questions . Answer key included

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Q1. [Dec 2015] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2015 Dec	3.5 M
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A hollow metallic sphere of radius a , which is kept at a potential V_0 has a charge Q at its centre.

The potential at a point outside the sphere, at a distance r from the centre, is

1. V_0

2. $\frac{Q}{4\pi\epsilon_0 r} + \frac{V_0 a}{r}$

3. $\frac{Q}{4\pi\epsilon_0 r} + \frac{V_0 a^2}{r^2}$

4. $\frac{V_0 a}{r}$

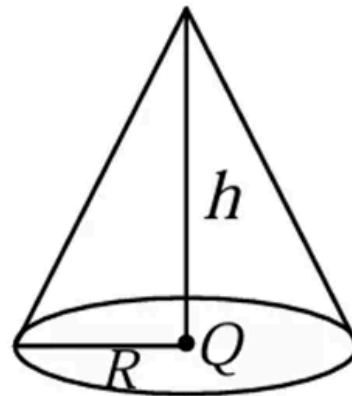
Q2. [Dec 2015] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2015 Dec	3.5 M
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Consider a charge Q at the origin of 3 - dimensional coordinate system. The flux of the electric field through the curved surface of a cone that has a height h and a circular base of radius R (as shown in the figure) is

1. $\frac{Q}{\epsilon_0}$
2. $\frac{Q}{2\epsilon_0}$
3. $\frac{hQ}{R\epsilon_0}$
4. $\frac{QR}{2h\epsilon_0}$



Q3. [Dec 2015] . 3.5 marks

Electromagnetism > Potential Formulation

CSIR NET	2015 Dec	3.5 M
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Given a uniform magnetic field $B = B_0 \hat{k}$ (where B_0 is a constant), a possible choice for the magnetic vector potential A is

1. $B_0 y \hat{i}$
2. $-B_0 y \hat{i}$
3. $B_0 (x \hat{j} + y \hat{i})$
4. $B_0 (x \hat{i} + y \hat{j})$

Q4. [Dec 2015] . 5.0 marks

Electromagnetism > Magnetostatics

CSIR NET	2015 Dec	5 M
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A small magnetic needle is kept at $(0,0)$ with its moment along the x -axis. Another small magnetic needle is at the point $(1,1)$ and is free to rotate in the xy - plane. In equilibrium the angle θ between their magnetic moments is such that

1. $\tan \theta = \frac{1}{3}$
2. $\tan \theta = 0$
3. $\tan \theta = 3$
4. $\tan \theta = 1$

Q5. [Dec 2015] . 5.0 marks

Electromagnetism > Radiations

CSIR NET	2015 Dec	5 M
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A dipole of moment \vec{p} , oscillating at frequency ω , radiates spherical waves. The vector potential at large distance is

$$\vec{A}(\vec{r}) = \frac{\mu_0}{4\pi} i\omega \frac{e^{ikr}}{r} \vec{p}$$

To order $\left(\frac{1}{r}\right)$ the magnetic field \vec{B} at a point $\vec{r} = r\hat{n}$ is

1. $-\frac{\mu_0}{4\pi} \frac{\omega^2}{c} (\hat{n} \cdot \vec{p}) \hat{n} \frac{e^{ikr}}{r}$
2. $-\frac{\mu_0}{4\pi} \frac{\omega^2}{c} (\hat{n} \times \vec{p}) \frac{e^{ikr}}{r}$
3. $-\frac{\mu_0}{4\pi} \omega^2 k (\hat{n} \cdot \vec{p}) \vec{p} \frac{e^{ikr}}{r}$
4. $-\frac{\pi_0}{4\pi} \frac{\omega^2}{c} \vec{p} \frac{e^{ikr}}{r}$

Q6. [Dec 2015] . 5.0 marks

Electromagnetism > Plasma

CSIR NET	2015 Dec	5 M
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The frequency dependent dielectric constant of a material is given by

$$\varepsilon(\omega) = 1 + \frac{A}{\omega_0^2 - \omega^2 - i\omega\gamma}$$

where A is a positive constant, ω_0 the resonant frequency and γ the damping coefficient. For an electromagnetic wave of angular frequency $\omega \ll \omega_0$ which of the following is true? (Assume that $\frac{\gamma}{\omega_0} \ll 1$).

1. There is negligible absorption of the wave
2. The wave propagation is highly dispersive
3. There is strong absorption of the electromagnetic wave
4. The group velocity and the phase velocity will have opposite sign

Q7. [June 2015] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2015 June	3.5 M
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A plane electromagnetic wave is travelling along the positive z -direction. The maximum electric field along the x direction is 10 V/m . The approximate maximum values of the power per unit area and the magnetic induction B , respectively, are

1. $3.3 \times 10^{-7} \text{ watts /m}^2$ and 10 tesla
2. $3.3 \times 10^{-7} \text{ watts /m}^2$ and $3.3 \times 10^{-8} \text{ tesla}$
3. 0.265 watts /m^2 and 10 tesla
4. 0.265 watts /m^2 and $3.3 \times 10^{-8} \text{ tesla}$

Q8. [June 2015] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2015 June	3.5 M
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Suppose the yz -plane forms a chargeless boundary between two media of permittivities ϵ_{left} and ϵ_{right} where $\epsilon_{\text{left}} : \epsilon_{\text{right}} = 1 : 2$. 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}_{right} is

1. $c(2\hat{i} + \hat{j} + \hat{k})$
2. $c(\hat{i} + 2\hat{j} + 2\hat{k})$
3. $c\left(\frac{1}{2}\hat{i} + \hat{j} + \hat{k}\right)$
4. $c\left(\hat{i} + \frac{1}{2}\hat{j} + \frac{1}{2}\hat{k}\right)$

Q9. [June 2015] . 3.5 marks

Electromagnetism > Magnetostatics

CSIR NET	2015 June	3.5 M
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A proton moves with a speed of 300 m/s in a circular orbit in the xy -plane in a magnetic field 1 tesla along the positive z direction. When an electric field of 1 V/m is applied along the positive y -direction. the centre of the circular orbit

1. remains stationary
2. moves at 1 m/s along the negative x direction
3. moves at 1 m/s along the positive z direction
4. moves at 1 m/s along the positive x direction

Q10. [June 2015] . 3.5 marks

Electromagnetism > Potential Formulation

CSIR NET	2015 June	3.5 M
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Which of the following transformations

$(V, \vec{A}) \rightarrow (V', \vec{A}')$ of the electrostatic potential V and the vector potential \vec{A} is a gauge transformation?

1. $(V' = V + ax, \vec{A}' = \vec{A} + at\hat{k})$
2. $(V' = V + ax, \vec{A}' = \vec{A} - at\hat{k})$
3. $(V' = V + ax, \vec{A}' = \vec{A} + at\hat{i})$
4. $(V' = V + ax, \vec{A}' = \vec{A} - at\hat{i})$

Q11. [June 2015] . 5.0 marks

Electromagnetism > Waveguides

CSIR NET	2015 June	5 M
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Consider a rectangular wave guide with transverse dimensions $2\text{ m} \times 1\text{ m}$ driven with an angular frequency $\omega = 10^9\text{ rad/s}$. Which transverse electric (TE) modes will propagate in this wave guide?

1. TE_{10} , TE_{01} and TE_{20}
2. TE_{10} , TE_{11} and TE_{20}
3. TE_{01} , TE_{10} and TE_{11}
4. TE_{01} , TE_{10} and TE_{22}

Q12. [June 2015] . 5.0 marks

Electromagnetism > EM Waves

CSIR NET	2015 June	5 M
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The electric and magnetic fields in the charge free region $z > 0$ are given by

$$\vec{E}(\vec{r}, t) = E_0 e^{-k_1 z} \cos(k_2 x - \omega t) \hat{j}$$

$$\vec{E}(\vec{r}, t) = \frac{E_0}{\omega} e^{-k_1 z} [k_1 \sin(k_2 x - \omega t) \hat{i} + k_2 \cos(k_2 x - \omega t) \hat{k}]$$

where ω , k_1 and k_2 are positive constants. The average energy flow in the x -direction is

1. $\frac{E_0^2 k_2}{2\mu_0 \omega} e^{-2k_1 z}$
2. $\frac{E_0^2 k_2}{\mu_0 \omega} e^{-2k_1 z}$
3. $\frac{E_0^2 k_1}{2\mu_0 \omega} e^{-2k_1 z}$
4. $\frac{1}{2} c \epsilon_0 E_0^2 e^{-2k_1 z}$

Q13. [June 2015] . 5.0 marks

Electromagnetism > Electrodynamics

CSIR NET	2015 June	5 M
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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 1 s . The charge transferred across any point in the wire is approximately

1. 3.1×10^{-4} coulomb
2. 3.4×10^{-4} coulomb
3. 4.2×10^{-4} coulomb
4. 5.2×10^{-4} coulomb

Q14. [June 2015] . 5.0 marks

Electromagnetism > Relativistic electromagnetism

CSIR NET	2015 June	5 M
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The Dirac Hamiltonian $H = c\vec{\alpha} \cdot \vec{p} + \beta mc^2$ for a free electron corresponds to the classical relation $E^2 = p^2 c^2 + m^2 c^4$. The classical energy-momentum relation of a particle of charge q in an electromagnetic potential (ϕ, \vec{A}) is

$$(E - q\phi)^2 = c^2 \left(\vec{p} - \frac{q}{c} \vec{A} \right)^2 + m^2 c^4.$$

Therefore, the Dirac Hamiltonian for an electron in an electromagnetic field is

1. $c\vec{\alpha} \cdot \vec{p} + \frac{e}{c} \vec{A} \cdot \vec{A} + \beta mc^2 - e\phi$
2. $c\vec{\alpha} \cdot \left(\vec{p} + \frac{e}{c} \vec{A} \right) + \beta mc^2 + e\phi$
3. $c \left(\vec{\alpha} \cdot \vec{p} + e\phi + \frac{e}{c} |\vec{A}| \right) + \beta mc^2$
4. $c\vec{\alpha} \cdot \left(\vec{p} + \frac{e}{c} \vec{A} \right) + \beta mc^2 - e\phi$

Q15. [Dec 2016] . 3.5 marks

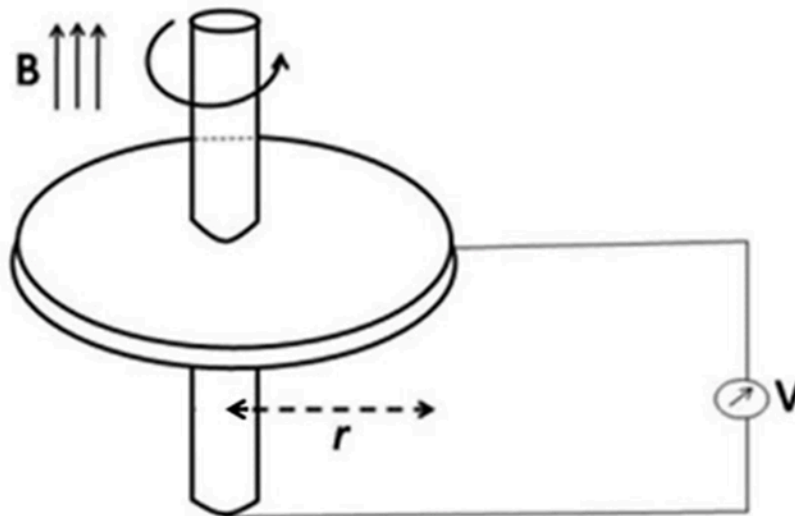
Electromagnetism > Electrodynamics

CSIR NET

2016 Dec

3.5M

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

1. depends on ω, B, r and ρ
2. depends on ω, B and r , but not on ρ
3. is zero because the flux through the loop is not changing
4. is zero because a current flows in the direction of B

Q16. [Dec 2016] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2016 Dec	3.5M
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The charge per unit length of a circular wire of radius a in the xy -plane, with its centre at the origin, is $\lambda = \lambda_0 \cos\theta$, where λ_0 is a constant and the angle θ is measured from the positive x -axis. The electric field at the centre of the circle is

$$1. \vec{E} = -\frac{\lambda_0}{4\epsilon_0 a} \hat{i}$$

$$2. \vec{E} = \frac{\lambda_0}{4\epsilon_0 a} \hat{i}$$

$$3. \vec{E} = -\frac{\lambda_0}{4\epsilon_0 a} \hat{j}$$

$$4. \vec{E} = \frac{\lambda_0}{4\pi\epsilon_0 a} \hat{k}$$

Q17. [Dec 2016] . 3.5 marks

Electromagnetism > Potential Formulation

CSIR NET	2016 Dec	3.5M
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Consider the operator $\vec{\pi} = \vec{p} - q\vec{A}$, where \vec{p} is the momentum operator, $\vec{A} = (A_x, A_y, A_z)$ is the vector potential and q denotes the electric charge. If

$\vec{B} = (B_x, B_y, B_z)$ denotes the magnetic field, the z -component of the vector operator $\vec{\pi} \times \vec{\pi}$ is

1. $iq\hbar B_z + q(A_x p_y - A_y p_x)$
2. $-iq\hbar B_z - q(A_x p_y - A_y p_x)$
3. $-iq\hbar B_z$
4. $iq\hbar B_z$

Q18. [Dec 2016] . 5.0 marks

Electromagnetism > Electrostatics

CSIR NET	2016 Dec	5M
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Suppose that free charges are present in a material of dielectric constant $\epsilon = 10$ and resistivity

$\rho = 10^{11} \Omega - \text{m}$. Using Ohm's law and the equation of continuity for charge, the time required for the charge density inside the material to decay by $1/e$ is closest to

1. 10^{-6} s
2. 10^6 s
3. 10^{12} s
4. 10 s

Q19. [Dec 2016] . 5.0 marks

Electromagnetism > Radiations

CSIR NET	2016 Dec	5M
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A particle with charge $-q$ moves with a uniform angular velocity ω in a circular orbit of radius a in the xy -plane, around a fixed charge $+q$, which is at the centre of the orbit at $(0,0,0)$. Let the intensity of radiation at the point $(0,0,R)$ be I_1 and at $(2R,0,0)$ be I_2 . The ratio I_2/I_1 , for $R \gg a$, is

1. 4

2. $\frac{1}{4}$ 3. $\frac{1}{8}$

4. 8

Q20. [Dec 2016] . 5.0 marks

Electromagnetism > Electrodynamics

CSIR NET	2016 Dec	5M
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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 $a/2$ from the centre of the plate, is

1. $\frac{\mu_0 I}{\pi a}$

2. $\frac{\mu_0 I}{2\pi a}$

3. $\frac{\mu_0 I}{a}$

4. $\frac{\mu_0 I}{4\pi a}$

Q21. [Dec 2016] . 5.0 marks

Electromagnetism > Electrostatics

CSIR NET	2016 Dec	5M
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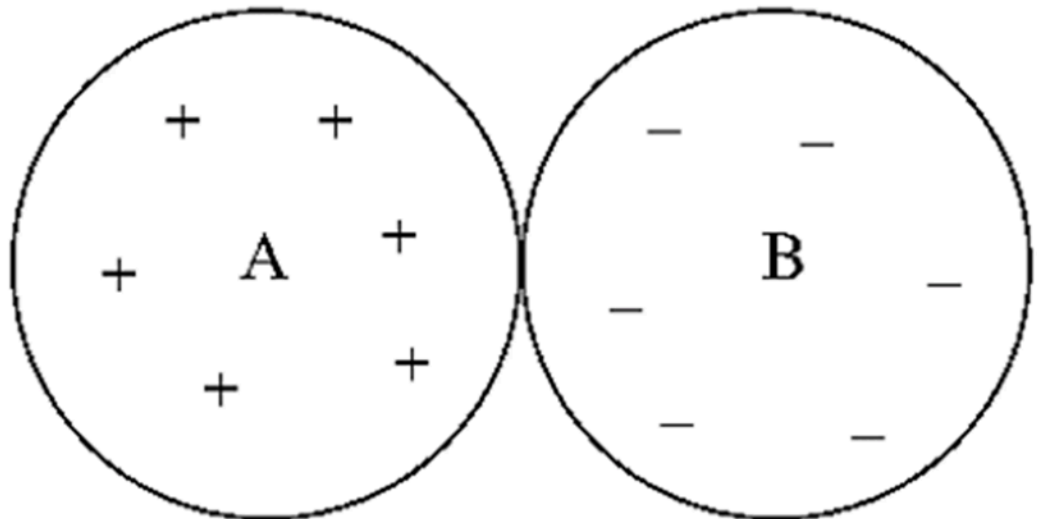
Two uniformly charged insulating solid spheres A and B, both of radius a , carry total charges $+Q$ and $-Q$, respectively. The spheres are placed touching each other as shown in the figure. If the potential at the centre of the sphere A is V_A and that at the centre of B is V_B , then the difference $V_A - V_B$ is

1. $\frac{Q}{4\pi\epsilon_0 a}$

2. $\frac{-Q}{2\pi\epsilon_0 a}$

3. $\frac{Q}{2\pi\epsilon_0 a}$

4. $\frac{-Q}{4\pi\epsilon_0 a}$



Q22. [June 2016] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2016 June	3.5M
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Four equal charges of $+Q$ each are kept at the vertices of a square of side R . A particle of mass m and charge $+Q$ is placed in the plane of the square at a short distance $a(\ll R)$ from the centre. If the motion of the particle is confined to the plane, it will undergo small oscillations with an angular frequency

1. $\sqrt{\frac{Q^2}{2\pi\epsilon_0 R^3 m}}$

2. $\sqrt{\frac{Q^2}{\pi\epsilon_0 R^3 m}}$

3. $\sqrt{\frac{\sqrt{2}Q^2}{\pi\epsilon_0 R^3 m}}$

4. $\sqrt{\frac{Q^2}{4\pi\epsilon_0 R^3 m}}$

Q23. [June 2016] . 3.5 marks

Electromagnetism > Capacitors

CSIR NET	2016 June	3.5M
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Two parallel plate capacitors, separated by distances x and $1.1x$ respectively, have a dielectric material of dielectric constant 3.0 inserted between the plates, and are connected to a battery of voltage V . The difference in charge on the second capacitor compared to the first is

1. +66%
2. +20%
3. -3.3%
4. -10%

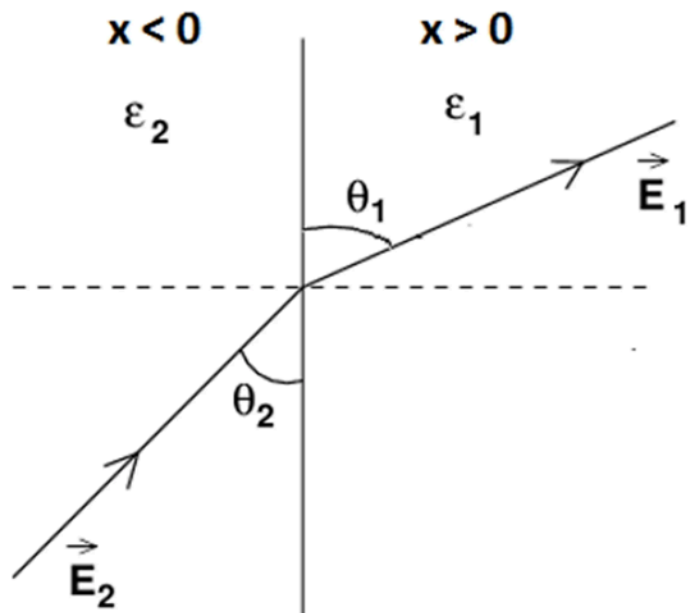
Q24. [June 2016] . 3.5 marks

Electromagnetism > Electric field in matter

CSIR NET	2016 June	3.5M
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The half space regions $x > 0$ 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

1. $\epsilon_1 \sin \theta_2 = \epsilon_2 \sin \theta_1$
2. $\epsilon_1 \tan \theta_2 = \epsilon_2 \tan \theta_1$
3. $\epsilon_1 \tan \theta_1 = \epsilon_2 \tan \theta_2$
4. $\epsilon_1 \sin \theta_1 = \epsilon_2 \sin \theta_2$



Q25. [June 2016] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2016 June	3.5M
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The x - and z -components of a static magnetic field in a region are $B_x = B_0(x^2 - y^2)$ and $B_z = 0$, respectively. Which of the following solutions for its y component is consistent with the Maxwell equations?

1. $B_y = B_0xy$
2. $B_y = -2B_0xy$
3. $B_y = -B_0(x^2 - y^2)$
4. $B_y = B_0\left(\frac{1}{3}x^3 - xy^2\right)$

Q26. [June 2016] . 3.5 marks

Electromagnetism > Electrodynamics

CSIR NET	2016 June	3.5M
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A magnetic field \mathbf{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 a constant velocity $\mathbf{v} = v\hat{x}$. Which of the following values of l and h will generate the largest EMF?

1. $l = 8, h = 3$
2. $l = 4, h = 6$
3. $l = 6, h = 4$
4. $l = 12, h = 2$

Q27. [June 2016] . 5.0 marks

Electromagnetism > Electrostatics

CSIR NET

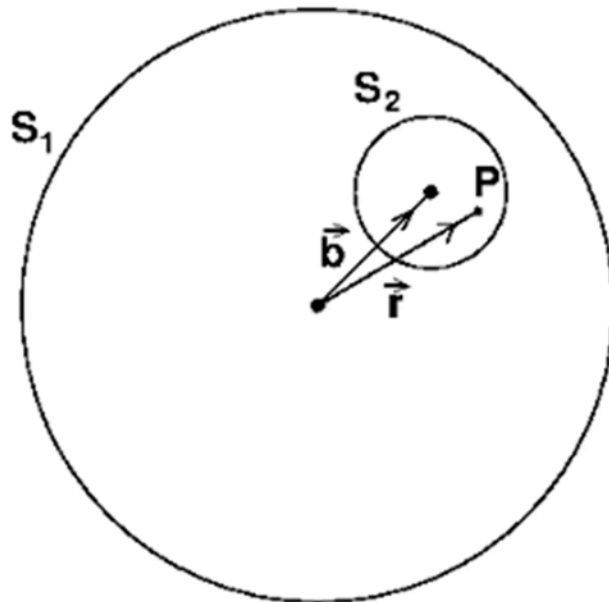
2016 June

5M

Consider a sphere S_1 of radius R which carries a uniform charge of density ρ . A smaller sphere S_2 of radius $a < R/2$ is cut out and removed from it. The centres of the two spheres are separated by the vector $\vec{b} = \hat{n}R/2$, as shown in the figure.

The electric field at a point P inside S_2 is

1. $\frac{\rho R}{3\epsilon_0} \hat{n}$
2. $\frac{\rho R}{3\epsilon_0 a} (\vec{r} - \hat{n}a)$
3. $\frac{\rho R}{6\epsilon_0} \hat{n}$
4. $\frac{\rho a}{3\epsilon_0 R} \vec{r}$



Q28. [June 2016] . 5.0 marks

Electromagnetism > Relativistic electromagnetism

CSIR NET	2016 June	5M
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The values of the electric and magnetic fields in a particular reference frame (in Gaussian units) are $\mathbf{E} = 3\hat{x} + 4\hat{y}$ and $\mathbf{B} = 3\hat{z}$, respectively. An inertial observer moving with respect to this frame measures the magnitude of the electric field to be $|\mathbf{E}'| = 4$. The magnitude of the magnetic field $|\mathbf{B}'|$ measured by him is

- 1.5
- 2.9
- 3.0
- 4.1

Q29. [June 2016] . 5.0 marks

Electromagnetism > Magnetostatics

CSIR NET	2016 June	5M
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A loop of radius a , carrying a current I , is placed in a uniform magnetic field \mathbf{B} . If the normal to the loop is denoted by \hat{n} , the force \mathbf{F} and the torque \mathbf{T} on the loop are

1. $\mathbf{F} = 0$ and $\mathbf{T} = \pi a^2 I \hat{n} \times \mathbf{B}$

2. $\mathbf{F} = \frac{\mu_0}{4\pi} \mathbf{I} \times \mathbf{B}$ and $\mathbf{T} = 0$

3. $\mathbf{F} = \frac{\mu_0}{4\pi} \mathbf{I} \times \mathbf{B}$ and $\mathbf{T} = I \hat{n} \times \mathbf{B}$

4. $\mathbf{F} = 0$ and $\mathbf{T} = \frac{1}{\mu_0 \epsilon_0} I \mathbf{B}$

Q30. [June 2016] . 5.0 marks

Electromagnetism > Waveguides

CSIR NET	2016 June	5M
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A waveguide has a square cross-section of side $2a$. For the TM modes of wavevector k , the transverse electromagnetic modes are obtained in terms of a function $\psi(x, y)$ which obeys the equation

$$\left[\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \left(\frac{\omega^2}{c^2} - k^2 \right) \right] \psi(x, y) = 0$$

with the boundary condition

$\psi(\pm a, y) = \psi(x, \pm a) = 0$. The frequency ω of the lowest mode is given by

1. $\omega^2 = c^2 \left(k^2 + \frac{4\pi^2}{a^2} \right)$

2. $\omega^2 = c^2 \left(k^2 + \frac{\pi^2}{a^2} \right)$

3. $\omega^2 = c^2 \left(k^2 + \frac{\pi^2}{2a^2} \right)$

4. $\omega^2 = c^2 \left(k^2 + \frac{\pi^2}{4a^2} \right)$

Q31. [Dec 2017] . 3.5 marks

Electromagnetism > Multipoles

CSIR NET	2017 Dec	3.5M
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Two point charges $+3Q$ and $-Q$ are placed at $(0,0,d)$ and $(0,0,2d)$ respectively, above an infinite grounded conducting sheet kept in the xy - plane. At a point $(0,0,z)$, where $z \gg d$, the electrostatic potential of this charge configuration would approximately be

1. $\frac{1}{4\pi\epsilon_0} \frac{d^2}{z^3} Q$

2. $\frac{1}{4\pi\epsilon_0} \frac{2d}{z^2} Q$

3. $\frac{1}{4\pi\epsilon_0} \frac{3d}{z^2} Q$

4. $-\frac{1}{4\pi\epsilon_0} \frac{d^2}{z^3} Q$

Q32. [Dec 2017] . 3.5 marks

Electromagnetism > Capacitors

CSIR NET	2017 Dec	3.5M
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A rectangular piece of dielectric material is inserted partially into the (air) gap between the plates of a parallel plate capacitor. The dielectric piece will

1. remain stationary where it is placed
2. be pushed out from the gap between the plates
3. be drawn inside the gap between the plates and its velocity does not change sign
4. execute an oscillatory motion in the region between the plates

Q33. [Dec 2017] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2017 Dec	3.5M
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An electromagnetic wave is travelling in free space (of permittivity ϵ_0) with electric field

$$\vec{E} = \hat{k}E_0 \cos q(x - ct)$$

The average power (per unit area) crossing planes parallel to $4x + 3y = 0$ will be

1. $\frac{4}{5} \epsilon_0 c E_0^2$
2. $\epsilon_0 c E_0^2$
3. $\frac{1}{2} \epsilon_0 c E_0^2$
4. $\frac{16}{25} \epsilon_0 c E_0^2$

Q34. [Dec 2017] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2017 Dec	3.5M
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A plane electromagnetic wave from within a dielectric medium (with $\epsilon = 4\epsilon_0$ and $\mu = \mu_0$) is incident on its boundary with air, at $z = 0$. The magnetic field in the medium is

$$\vec{H} = \hat{j}H_0 \cos(\omega t - kx - k\sqrt{3}z),$$

where ω and k are positive constants.

The angles of reflection and refraction are, respectively,

1. 45° and 60°
2. 30° and 90°
3. 30° and 60°
4. 60° and 90°

Q35. [Dec 2017] . 5.0 marks

Electromagnetism > Relativistic electromagnetism

CSIR NET	2017 Dec	5M
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In the rest frame S_1 of a point particle with electric charge q_1 another point particle with electric charge q_2 moves with a speed v parallel to the x -axis at a perpendicular distance l . The magnitude of the electromagnetic force felt by q_1 due to q_2 when the distance between them is minimum, is

[In the following $\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$]

1. $\frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{\gamma l^2}$
2. $\frac{1}{4\pi\epsilon_0} \frac{\gamma q_1 q_2}{l^2}$
3. $\frac{1}{4\pi\epsilon_0} \frac{\gamma q_1 q_2}{l^2} \left(1 + \frac{v^2}{c^2}\right)$
4. $\frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{\gamma l^2} \left(1 + \frac{v^2}{c^2}\right)$

Q36. [Dec 2017] . 5.0 marks

Electromagnetism > Electrodynamics

CSIR NET	2017 Dec	5M
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A circular current carrying loop of radius a carries a steady current. A constant electric charge is kept at the centre of the loop. The electric and magnetic fields, \vec{E} and \vec{B} respectively, at a distance d vertically above the centre of the loop satisfy

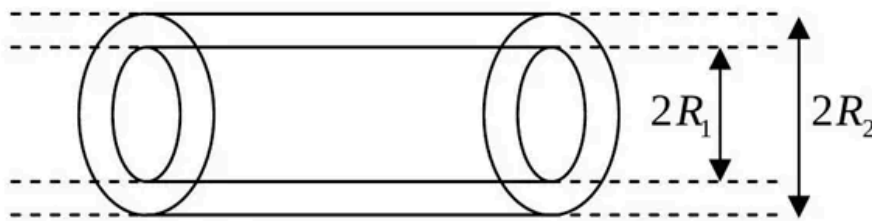
1. $\vec{E} \perp \vec{B}$
2. $\vec{E} = 0$
3. $\vec{\nabla}(\vec{E} \cdot \vec{B}) = 0$
4. $\vec{\nabla} \cdot (\vec{E} \times \vec{B}) = 0$

Q37. [June 2017] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2017 June	3.5M
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Two long hollow co-axial conducting cylinders of radii R_1 and R_2 ($R_1 < R_2$) are placed in vacuum as shown in the figure below.



The inner cylinder carries a charge $+\lambda$ per unit length and the outer cylinder carries a charge $-\lambda$ per unit length. The electrostatic energy per unit length of this system is

1. $\frac{\lambda^2}{\pi\epsilon_0} \ln(R_2/R_1)$
2. $\frac{\lambda^2}{4\pi\epsilon_0} (R_2^2/R_1^2)$
3. $\frac{\lambda^2}{4\pi\epsilon_0} \ln(R_2/R_1)$
4. $\frac{\lambda^2}{2\pi\epsilon_0} \ln(R_2/R_1)$

Q38. [June 2017] . 3.5 marks

Electromagnetism > Magnetostatics

CSIR NET	2017 June	3.5M
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A set of N concentric circular loops of wire, each carrying a steady current I in the same direction, is arranged in a plane. The radius of the first loop is $r_1 = a$ and the radius of the n^{th} loop is given by $r_n = nr_{n-1}$. The magnitude B of the magnetic field at the centre of the circles in the limit $N \rightarrow \infty$, is

1. $\mu_0 I(e^2 - 1)/4\pi a$
2. $\mu_0 I(e - 1)/\pi a$
3. $I(e^2 - 1)/8a$
4. $\mu_0 I(e - 1)/2a$

Q39. [June 2017] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2017 June	3.5M
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An electromagnetic wave (of wavelength λ_0 in free space) travels through an absorbing medium with dielectric permittivity given by $\varepsilon = \varepsilon_R + i\varepsilon_I$ where $\frac{\varepsilon_I}{\varepsilon_R} = \sqrt{3}$. If the skin depth is $\frac{\lambda_0}{4\pi}$, the ratio of the amplitude of electric field E to that of the magnetic field B , in the medium (in ohms) is

1. 120π
2. 377
3. $30\sqrt{2}\pi$
4. 30π

Q40. [June 2017] . 3.5 marks

Electromagnetism > Potential Formulation

CSIR NET	2017 June	3.5M
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The vector potential $\vec{A} = ke^{-at}r\hat{r}$ (where a and k are constants) corresponding to an electromagnetic field is changed to $\vec{A}' = -ke^{-at}r\hat{r}$. This will be a gauge transformation if the corresponding change $\phi' - \phi$ in the scalar potential is

1. akr^2e^{-at}
2. $2akr^2e^{-at}$
3. $-akr^2e^{-at}$
4. $-2akr^2e^{-at}$

Q41. [June 2017] . 5.0 marks

Electromagnetism > Radiations

CSIR NET	2017 June	5M
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An electron is decelerated at a constant rate starting from an initial velocity u (where $u \ll c$) to $u/2$ during which it travels a distance s . The amount of energy lost to radiation is

1. $\frac{\mu_0 e^2 u^2}{3\pi m c^2 s}$

2. $\frac{\mu_0 e^2 u^2}{6\pi m c^2 s}$

3. $\frac{\mu_0 e^2 u}{8\pi m c s}$

4. $\frac{\mu_0 e^2 u}{16\pi m c s}$

Q42. [June 2017] . 5.0 marks

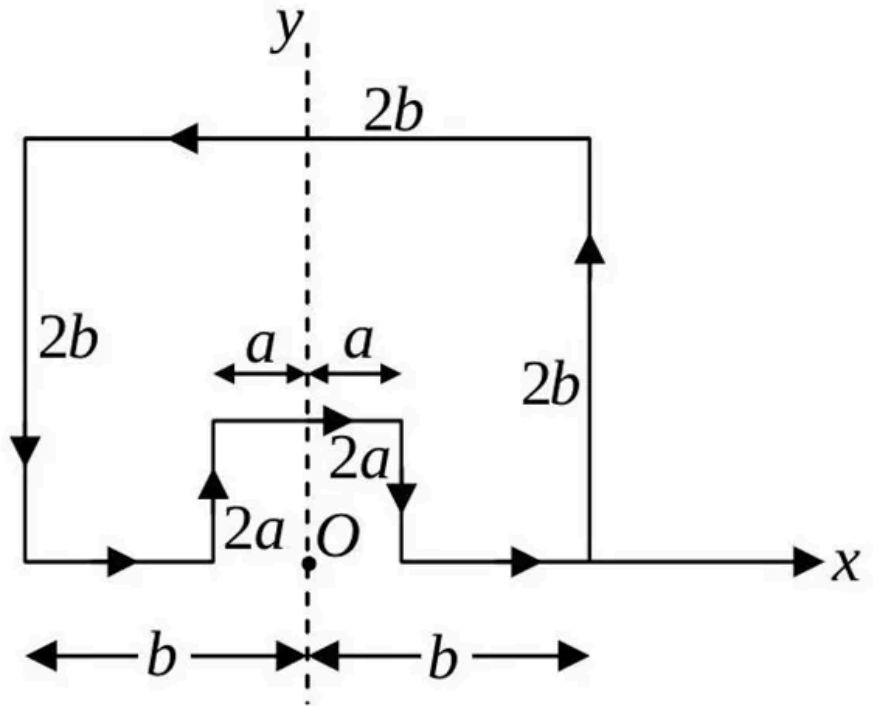
Electromagnetism > Magnetostatics

CSIR NET	2017 June	5M
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A constant current I is flowing in a piece of wire that is bent into a loop as shown in the figure.

The magnitude of the magnetic field at the point O is

1. $\frac{\mu_0 I}{4\pi\sqrt{5}} \ln\left(\frac{a}{b}\right)$
2. $\frac{\mu_0 I}{4\pi\sqrt{5}} \left(\frac{1}{a} - \frac{1}{b}\right)$
3. $\frac{\mu_0 I}{4\pi\sqrt{5}} \left(\frac{1}{a}\right)$
4. $\frac{\mu_0 I}{4\pi\sqrt{5}} \left(\frac{1}{b}\right)$



Q43. [June 2017] . 5.0 marks

Electromagnetism > Electrostatics

CSIR NET	2017 June	5M
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The charge distribution inside a material of conductivity σ and permittivity ϵ at initial time $t = 0$ is $\rho(r, 0) = \rho_0$, a constant. At subsequent times $\rho(r, t)$ is given by

1. $\rho_0 \exp\left(-\frac{\sigma t}{\epsilon}\right)$
2. $\frac{1}{2}\rho_0 \left[1 + \exp\left(\frac{\sigma t}{\epsilon}\right)\right]$
3. $\frac{\rho_0}{\left[1 - \exp\left(\frac{\sigma t}{\epsilon}\right)\right]}$
4. $\rho_0 \cosh \frac{\sigma t}{\epsilon}$

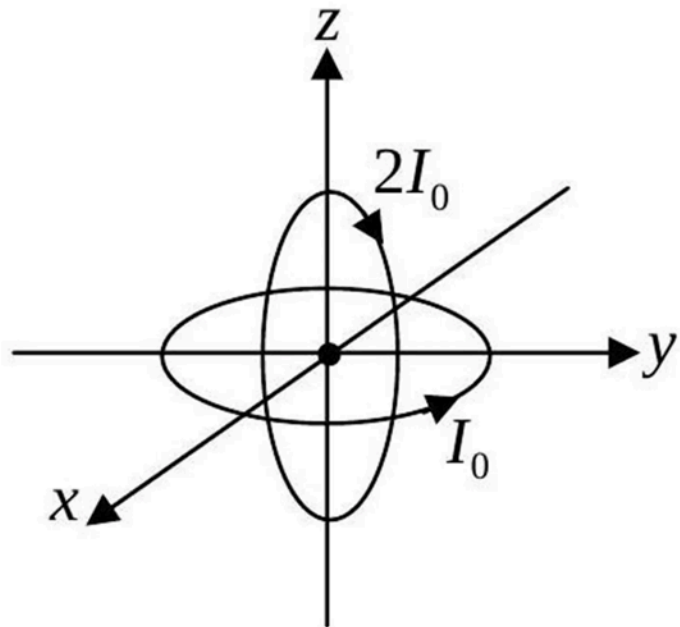
Q44. [Dec 2018] . 3.5 marks

Electromagnetism > Magnetostatics

CSIR NET	2018 Dec	3.5M
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Two current-carrying circular loops, each of radius R , are placed perpendicular to each other, as shown in the figure. The loop in the xy -plane carries a current I_0 while that in the xz -plane carries a current $2I_0$. The resulting magnetic field \vec{B} at the origin is

1. $\frac{\mu_0 I_0}{2R} [2\hat{j} + \hat{k}]$
2. $\frac{\mu_0 I_0}{2R} [2\hat{j} - \hat{k}]$
3. $\frac{\mu_0 I_0}{2R} [-2\hat{j} + \hat{k}]$
4. $\frac{\mu_0 I_0}{2R} [-2\hat{j} - \hat{k}]$



Q45. [Dec 2018] . 3.5 marks

Electromagnetism > Electrostatics

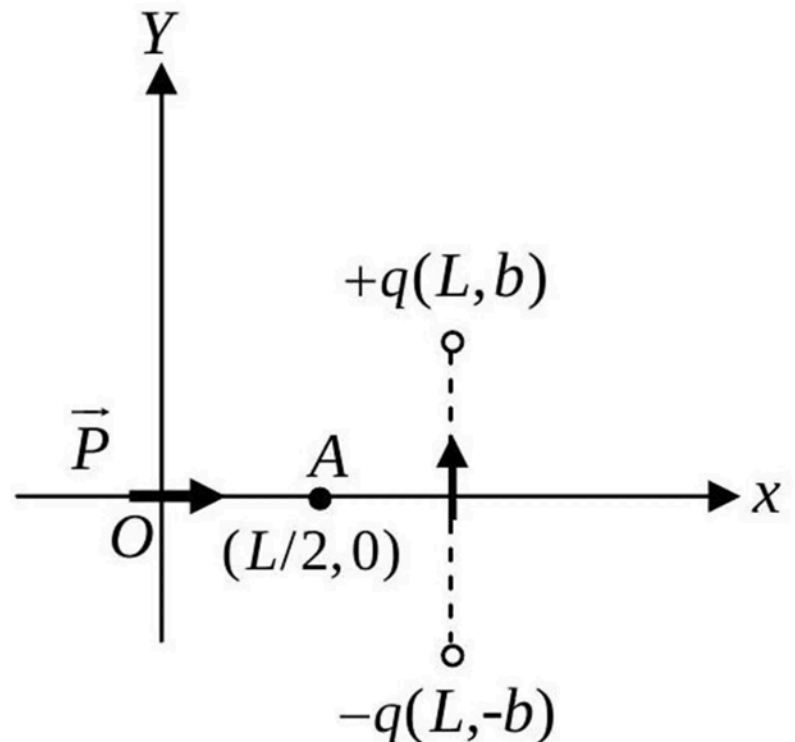
CSIR NET

2018 Dec

3.5M

An electric dipole of dipole moment $\vec{P} = qb\hat{i}$ is placed at origin in the vicinity of two charges $+q$ and $-q$ at (L, b) and $(L, -b)$, respectively, as shown in the figure. The electrostatic potential at the point $(\frac{L}{2}, 0)$ is

1. $\frac{qb}{\pi\epsilon_0} \left(\frac{1}{L^2} + \frac{2}{L^2+4b^2} \right)$
2. $\frac{4qbL}{\pi\epsilon_0 [L^2+4b^2]^{3/2}}$
3. $\frac{qb}{\pi\epsilon_0 L^2}$
4. $\frac{3qb}{\pi\epsilon_0 L^2}$



Q46. [Dec 2018] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2018 Dec	3.5M
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An electromagnetic wave propagates in a nonmagnetic medium with relative permittivity $\epsilon = 4$. The magnetic field for this wave is

$$\vec{H}(x, y) = \hat{k}H_0 \cos(\omega t - \alpha x - \alpha\sqrt{3}y)$$

where H_0 is a constant. The corresponding electric field $\vec{E}(x, y)$ is

1. $\frac{1}{4}\mu_0 H_0 c(-\sqrt{3}\hat{i} + \hat{j})\cos(\omega t - \alpha x - \alpha\sqrt{3}y)$
2. $\frac{1}{4}\mu_0 H_0 c(\sqrt{3}\hat{i} + \hat{j})\cos(\omega t - \alpha x - \alpha\sqrt{3}y)$
3. $\frac{1}{4}\mu_0 H_0 c(\sqrt{3}\hat{i} - \hat{j})\cos(\omega t - \alpha x - \alpha\sqrt{3}y)$
4. $\frac{1}{4}\mu_0 H_0 c(-\sqrt{3}\hat{i} - \hat{j})\cos(\omega t - \alpha x - \alpha\sqrt{3}y)$

Q47. [Dec 2018] . 5.0 marks

Electromagnetism > Relativistic electromagnetism

CSIR NET	2018 Dec	5M
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In an inertial frame uniform electric and magnetic field \vec{E} and \vec{B} are perpendicular to each other and satisfy $|\vec{E}|^2 - |\vec{B}|^2 = 29$ (in suitable units). In another inertial frame, which moves at a constant velocity with respect to the first frame, the magnetic field is $2\sqrt{5}\hat{k}$. In the second frame, an electric field consistent with the previous observations is

1. $\frac{7}{\sqrt{2}}(\hat{i} + \hat{j})$
2. $7(\hat{i} + \hat{k})$
3. $\frac{7}{\sqrt{2}}(\hat{i} + \hat{k})$
4. $7(\hat{i} + \hat{j})$

Q48. [Dec 2018] . 5.0 marks

Electromagnetism > Plasma

CSIR NET	2018 Dec	5M
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Electromagnetic wave of angular frequency ω is propagating in a medium in which, over a band of

frequencies the refractive index is $n(\omega) \approx 1 - \left(\frac{\omega}{\omega_0}\right)^2$,

where ω_0 is a constant. The ratio $\frac{v_g}{v_p}$ of the group

velocity to the phase velocity at $\omega = \frac{\omega_0}{2}$ is

1. 3
2. $\frac{1}{4}$
3. $\frac{2}{3}$
4. 2

Q49. [Dec 2018] . 5.0 marks

Electromagnetism > Magnetostatics

CSIR NET	2018 Dec	5M
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A rotating spherical shell of uniform surface charge and mass density has total mass M and charge Q . If its angular momentum is L and magnetic moment is μ , then the ratio $\frac{\mu}{L}$ is

1. $\frac{Q}{3M}$
2. $\frac{2Q}{3M}$
3. $\frac{Q}{2M}$
4. $\frac{3Q}{4M}$

Q50. [June 2018] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2018 June	3.5M
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Two-point charges $+2Q$ and $-Q$ are kept at point with Cartesian coordinates $(1,0,0)$, respectively, in front of an infinite grounded conducting plate at $x = 0$. The potential at $(x, 0, 0)$ for $x \gg 1$ depends on x as

1. x^{-3}
2. x^{-5}
3. x^{-2}
4. x^{-4}

Q51. [June 2018] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2018 June	3.5M
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In The electric field of a plane wave in a conducting medium is given by

$$\vec{E}(z, t) = \hat{i}E_0 e^{-z/3a} \cos\left(\frac{z}{\sqrt{3}a} - \omega t\right),$$

where ω is the angular frequency and $a > 0$ is a constant. The phase difference between the magnetic field \vec{B} and the electric field \vec{E} is

1. 30° and \vec{B} lags behind \vec{E}
2. 30° and \vec{E} lags behind \vec{B}
3. 60° and \vec{E} lags behind \vec{B}
4. 60° and \vec{B} lags behind \vec{E}

Q52. [June 2018] . 3.5 marks

Electromagnetism > Potential Formulation

CSIR NET	2018 June	3.5M
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The electric field \vec{E} and the magnetic field \vec{B} corresponding to the scalar and vector potentials,

$$V(x, y, z, t) = 0 \text{ and } \vec{A}(x, y, z, t) = \frac{1}{2} \hat{k} \mu_0 A_0 (ct - x),$$

where A_0 is a constant, are

1. $\vec{E} = 0$ and $\vec{B} = \frac{1}{2} \hat{j} \mu_0 A_0$

2. $\vec{E} = -\frac{1}{2} \hat{k} \mu_0 A_0 c$ and $\vec{B} = \frac{1}{2} \hat{j} \mu_0 A_0$

3. $\vec{E} = 0$ and $\vec{B} = -\frac{1}{2} \hat{i} \mu_0 A_0$

4. $\vec{E} = \frac{1}{2} \hat{k} \mu_0 A_0 c$ and $\vec{B} = -\frac{1}{2} \hat{i} \mu_0 A_0$

Q53. [June 2018] . 5.0 marks

Electromagnetism > Magnetostatics

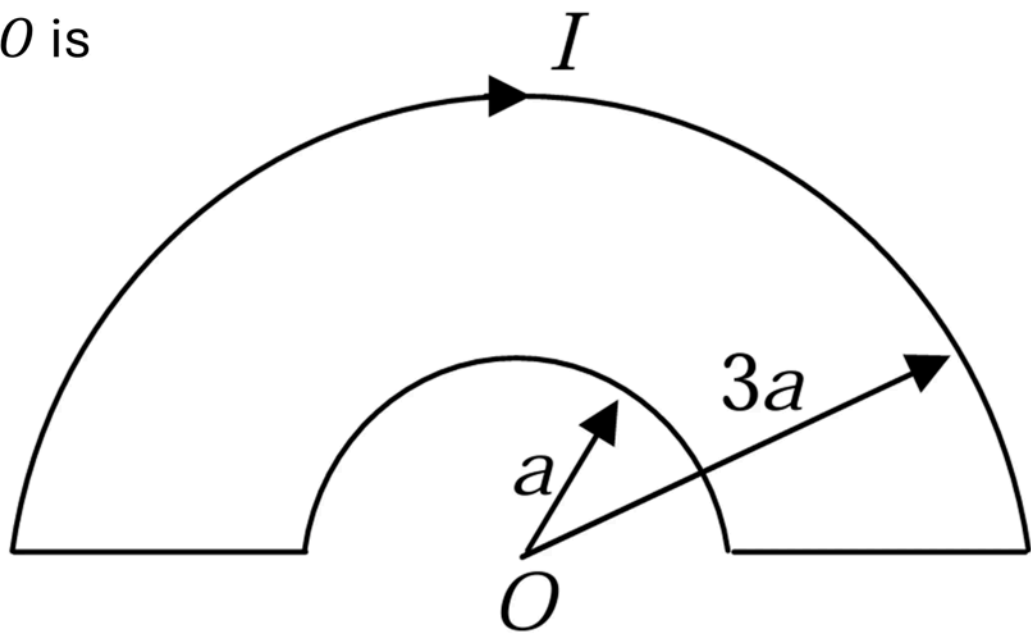
CSIR NET

2018 June

5M

The loop shown in the figure below carries a steady current I . The magnitude of the magnetic field at the point O is

1. $\frac{\mu_0 I}{2a}$
2. $\frac{\mu_0 I}{6a}$
3. $\frac{\mu_0 I}{4a}$
4. $\frac{\mu_0 I}{3a}$



Q54. [June 2018] . 5.0 marks

Electromagnetism > Radiations

CSIR NET	2018 June	5M
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In the region far from a source, the time dependent electric field at a point (r, θ, ϕ) is

$$\vec{E}(r, \theta, \phi) = \hat{\phi} E_0 \omega^2 \left(\frac{\sin \theta}{r} \right) \cos \left[\omega \left(t - \frac{r}{c} \right) \right]$$

where ω is angular frequency of the source. The total power radiated (averaged over a cycle) is

1. $\frac{2\pi E_0^2 \omega^4}{3 \mu_0 c}$
2. $\frac{4\pi E_0^2 \omega^4}{3 \mu_0 c}$
3. $\frac{4 E_0^2 \omega^4}{3\pi \mu_0 c}$
4. $\frac{2 E_0^2 \omega^4}{3 \mu_0 c}$

Q55. [June 2018] . 5.0 marks

Electromagnetism > Waveguides

CSIR NET

2018 June

5M

A hollow waveguide supports transverse electric (TE) modes with the dispersion relation $k = \frac{1}{c} \sqrt{\omega^2 - \omega_{mn}^2}$, where ω_{mn} is the mode frequency. The speed of flow of electromagnetic energy at the mode frequency is

1. c
2. ω_{mn}/k
3. 0
4. ∞

Q56. [Dec 2019] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2019 Dec	3.5M
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The yz - plane at $x = 0$ carries a uniform surface charge density σ . A unit point charge is moved from a point $(\delta, 0, 0)$ on one side of the plane to a point $(-\delta, 0, 0)$ on the other side. If δ is an infinitesimally small positive number, the work done in moving the charge is

1. 0

2. $\frac{\sigma}{\epsilon_0} \delta$

3. $-\frac{\sigma}{\epsilon_0} \delta$

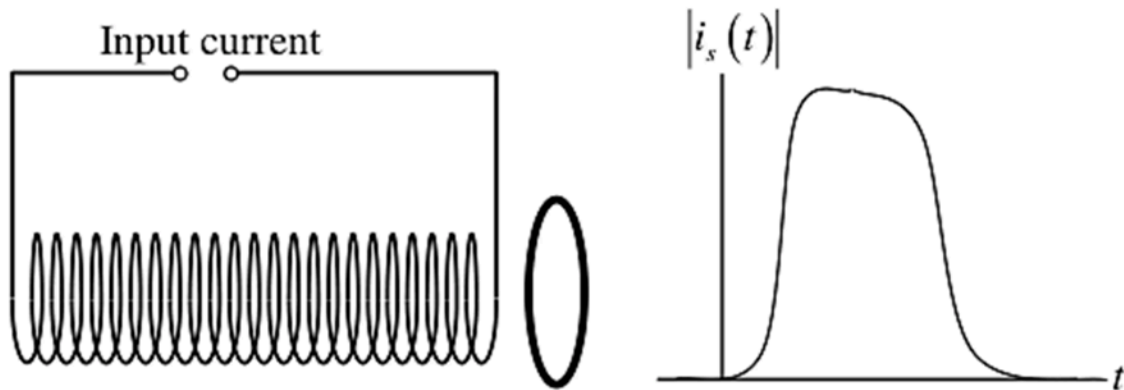
4. $\frac{2\sigma}{\epsilon_0} \delta$

Q57. [Dec 2019] . 3.5 marks

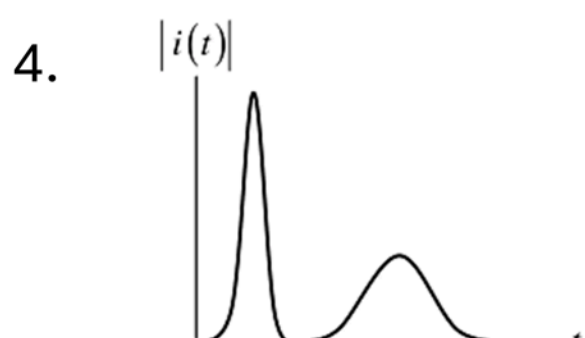
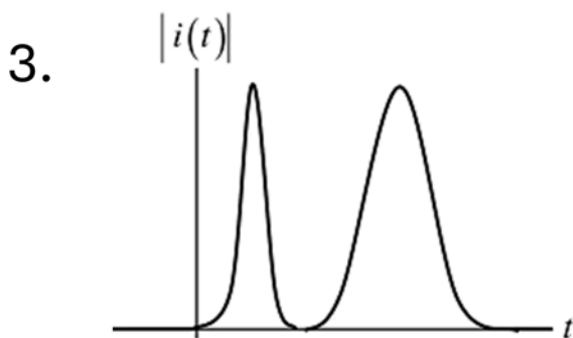
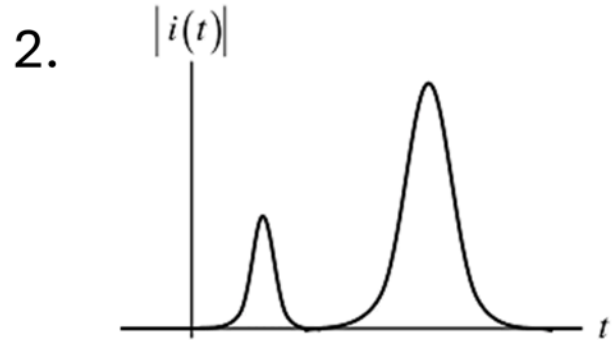
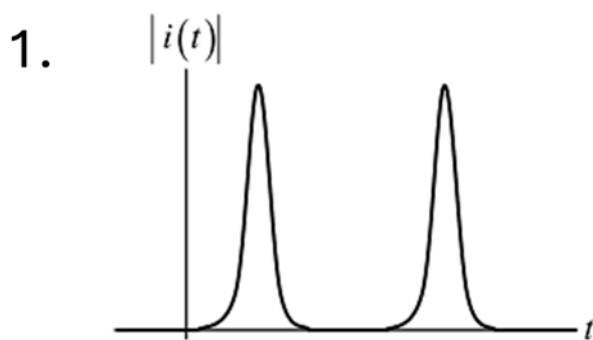
Electromagnetism > Electrodynamics

CSIR NET	2019 Dec	3.5M
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A circular conducting wire loop is placed close to a solenoid as shown in the figure below. Also shown is the current through the 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



Q58. [Dec 2019] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2019 Dec	3.5M
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The electric field of an electromagnetic wave is $\vec{E} = \hat{i}\sqrt{2}\sin(kz - \omega t)Vm^{-1}$. The average flow of energy per unit area per unit time, due to this wave, is

1. $27 \times 10^4 W/m^2$
2. $27 \times 10^{-4} W/m^2$
3. $27 \times 10^{-2} W/m^2$
4. $27 \times 10^2 W/m^2$

Q59. [Dec 2019] . 3.5 marks

Electromagnetism > Magnetostatics

CSIR NET	2019 Dec	3.5M
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A positively charged particle is placed at the origin (with zero initial velocity) in the presence of a constant electric and a constant magnetic field along the positive z and x -directions, respectively. At large times, the overall motion of the particle is adrift along the

1. positive y -direction
2. negative z -direction
3. positive z -direction
4. negative y -direction

Q60. [Dec 2019] . 5.0 marks

Electromagnetism > Radiations

CSIR NET

2019 Dec

5M

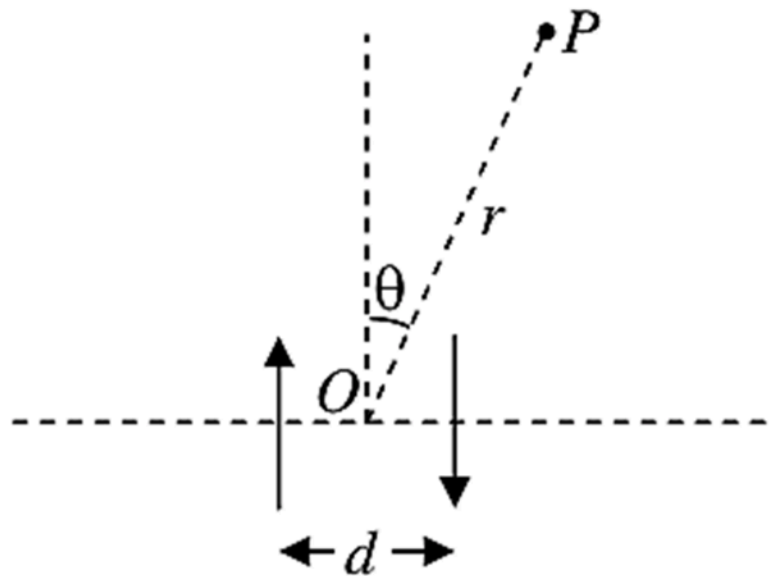
The phase difference between two small oscillating electric dipoles, separated by a distance d , is π . If the wavelength of the radiation is λ , the condition for constructive interference between the two dipolar radiations at a point P when $r \gg d$ (symbols are as shown in the figure and n is an integer) is

$$1. d \sin \theta = \left(n + \frac{1}{2} \right) \lambda$$

$$2. d \sin \theta = n \lambda$$

$$3. d \cos \theta = n \lambda$$

$$4. d \cos \theta = \left(n + \frac{1}{2} \right) \lambda$$



Q61. [Dec 2019] . 5.0 marks

Electromagnetism > EM Waves

CSIR NET	2019 Dec	5M
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An alternating current $I(t) = I_0 \cos(\omega t)$ flows through a circular wire loop of radius R , lying in the xy -plane, and centered at the origin. The electric field $\vec{E}(\vec{r}, t)$ and the magnetic field $\vec{B}(\vec{r}, t)$ are measured at a point \vec{r} such that $r \gg \frac{c}{\omega} \gg R$, where $\vec{r} = |\vec{r}|$. Which one of the following statements is correct?

1. The time-averaged $|\vec{E}(\vec{r}, t)| \propto \frac{1}{r^2}$
2. The time-averaged $|\vec{E}(\vec{r}, t)| \propto \omega^2$
3. The time-averaged $|\vec{B}(\vec{r}, t)|$ as a function of the polar angle θ has a minimum at

$$\theta = \frac{\pi}{2}$$

4. $\vec{B}(\vec{r}, t)$ is along the azimuthal direction

Q62. [Dec 2019] . 5.0 marks

Electromagnetism > Waveguides

CSIR NET	2019 Dec	5M
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A metallic wave guide of square cross-section of side L is excited by an electromagnetic wave of wave-number k . The group velocity of the TE_{11} mode is

1.
$$\frac{ckL}{\sqrt{k^2L^2 + \pi^2}}$$

2.
$$\frac{c}{kL} \sqrt{k^2L^2 - 2\pi^2}$$

3.
$$\frac{c}{kL} \sqrt{k^2L^2 - \pi^2}$$

4.
$$\frac{ckL}{\sqrt{k^2L^2 + 2\pi^2}}$$

Q63. [Dec 2019] . 5.0 marks

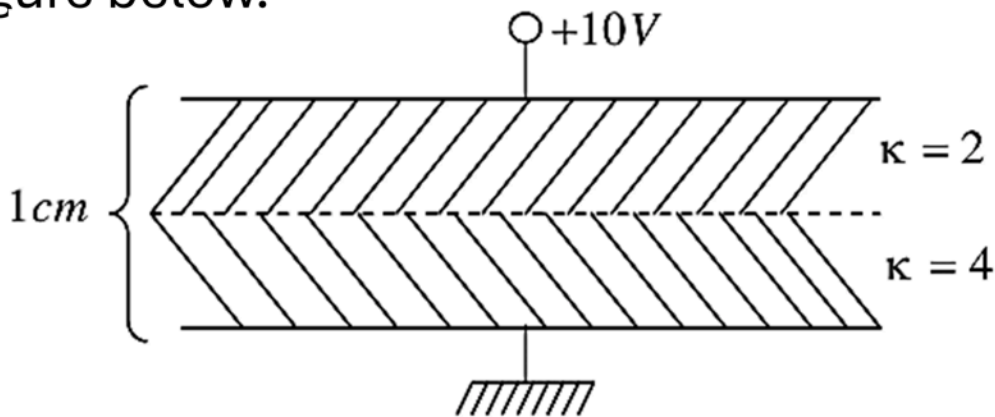
Electromagnetism > Electric field in matter

CSIR NET

2019 Dec

5M

A parallel plate capacitor with 1 cm separation between the plates has two layers of dielectric with dielectric constants $\kappa = 2$ and $\kappa = 4$, as shown in the figure below.



If a potential difference of 10 V is applied between the plates, the magnitude of the bound surface charge density (in units of C/m^2) at the junction of the dielectrics is

1. $250\epsilon_0$
2. $2000\epsilon_0/3$
3. $2000\epsilon_0$
4. $200\epsilon_0/3$

Q64. [June 2019] . 3.5 marks

Electromagnetism > Magnetostatics

CSIR NET	2019 June	3.5M
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Consider a planar wire loop as an n -sided regular polygon, in which R is the distance from the centre to a vertex. If a steady current I flows through the wire, the magnitude of the magnetic field at the centre of the Loop is

1. $\frac{\mu_0 I}{2R} \sin\left(\frac{2\pi}{n}\right)$
2. $\frac{\mu_0 n I}{4\pi R} \sin\left(\frac{\pi}{n}\right)$
3. $\frac{\mu_0 n I}{2\pi R} \tan\left(\frac{2\pi}{n}\right)$
4. $\frac{\mu_0 n I}{2\pi R} \tan\left(\frac{\pi}{n}\right)$

Q65. [June 2019] . 3.5 marks

Electromagnetism > Electric field in matter

CSIR NET	2019 June	3.5M
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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.)

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

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

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

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

Q66. [June 2019] . 5.0 marks

Electromagnetism > Relativistic electromagnetism

CSIR NET	2019 June	5M
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A inertial observer A at rest measures the electric and magnetic field $E = (\alpha, 0, 0)$ and $B = (\alpha, 0, 2\alpha)$ in a region, where α is a constant. Another inertial observer B , moving with a constant velocity with respect to A , measures the fields as $E' = (E'_x, \alpha, 0)$ and $B' = (\alpha, B'_y, \alpha)$. Then in units $c = 1$, E'_x and B'_y are given, respectively, by

1. -2α and α
2. 2α and $-\alpha$
3. α and -2α
4. $-\alpha$ and 2α

Q67. [June 2020] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2020 June	3.5M
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Three point charges q are placed at the corners of an equilateral triangle. Another point charge $-Q$ is placed at the centroid of the triangle. If the force on each of the charges q vanishes, then the ratio Q/q is

1. $\sqrt{3}$
2. $\frac{1}{\sqrt{3}}$
3. $\frac{1}{3\sqrt{3}}$
4. $\frac{1}{3}$

Q68. [June 2020] . 3.5 marks

Electromagnetism > Magnetostatics

CSIR NET	2020 June	3.5M
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Three infinitely long wires, each carrying equal current are placed in the xy - plane along $x = 0, +d$ and $-d$. On the xy -plane, the magnetic field vanishes at

1. $x = \pm \frac{d}{2}$

2. $x = \pm d \left(1 + \frac{1}{\sqrt{3}}\right)$

3. $x = \pm d \left(1 - \frac{1}{\sqrt{3}}\right)$

4. $x = \pm \frac{d}{\sqrt{3}}$

Q69. [June 2020] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2020 June	3.5M
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Let $\vec{E}(x, y, z, t) = \vec{E}_0 \cos(2x + 3y - \omega t)$, where ω is a constant, be the electric field of an electromagnetic wave travelling in vacuum. Which of the following vectors is a valid choice for \vec{E}_0 ?

1. $\hat{i} - \frac{3}{2}\hat{j}$
2. $\hat{i} + \frac{3}{2}\hat{j}$
3. $\hat{i} + \frac{2}{3}\hat{j}$
4. $\hat{i} - \frac{2}{3}\hat{j}$

Q70. [June 2020] . 5.0 marks

Electromagnetism > EM Waves

CSIR NET	2020 June	5M
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A spacecraft of mass $m = 1000 \text{ kg}$ has a fully reflecting sail that is oriented perpendicular to the direction of the sun. The sun radiates 10^{26} W and has a mass $M = 10^{30} \text{ kg}$. Ignoring the effect of the planets, for the gravitational pull of the sun to balance the radiation pressure on the sail, the area of the sail will be

1. 10^2 m^2
2. 10^4 m^2
3. 10^8 m^2
4. 10^6 m^2

Q71. [June 2020] . 5.0 marks

Electromagnetism > Relativistic electromagnetism

CSIR NET	2020 June	5M
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The electric field due to a uniformly charged infinite line along the z - axis, as observed in the rest frame

S of the line charge, is $\vec{E}(\vec{r}) = \frac{\lambda}{2\pi\epsilon_0} \frac{x\hat{i}+y\hat{j}}{(x^2+y^2)}$. In a frame

M moving with a constant speed v with respect to S along the z - direction, the electric field \vec{E}' is (in the

following $\beta = v/c$ and $\gamma = 1/\sqrt{1 - \beta^2}$)

1. $E'_x = E_x$ and $E'_y = E_y$
2. $E'_x = \beta\gamma E_x$ and $E'_y = \beta\gamma E_y$
3. $E'_x = E_x/\gamma$ and $E'_y = E_y/\gamma$
4. $E'_x = \gamma E_x$ and $E'_y = \gamma E_y$

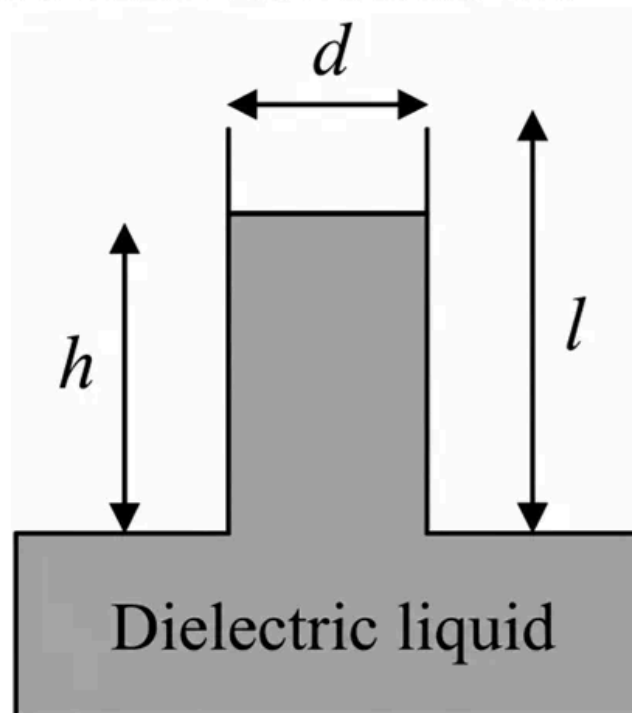
Q72. [June 2020] . 5.0 marks

Electromagnetism > Capacitors

CSIR NET	2020 June	5M
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A parallel plate capacitor with rectangular plates of length l , breadth b and plate separation d , is held vertically on the surface of a dielectric liquid of dielectric constant κ and density ρ as shown in the figure. The length and breadth are large enough for edge effects to be neglected. The plates of the capacitor are kept at a constant voltage difference V . Ignoring effects of surface tension, the height h upto which the liquid level rises inside the capacitor, is

1. $\frac{V^2 \epsilon_0 (\kappa - 1)}{\rho g b d}$
2. $\frac{V^2 \epsilon_0 (\kappa - 1)}{2 \rho g b^2}$
3. $\frac{V^2 \epsilon_0 (\kappa - 1)}{2 \rho g d^2}$
4. $\frac{V^2 \epsilon_0 (\kappa - 1)}{\rho g d^2}$



Q73. [June 2021] . 3.5 marks

Electromagnetism > Magnetostatics

CSIR NET	2021 June	3.5M
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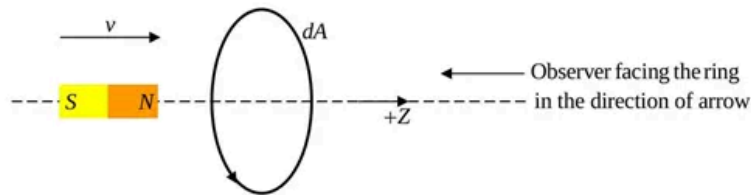
The vector potential for an almost point like magnetic dipole located at the origin is $\vec{A} = \frac{\mu \sin \theta}{4\pi r^2} \hat{\phi}$ where (r, θ, ϕ) denote the spherical polar coordinates and $\hat{\phi}$ is the unit vector along $\hat{\phi}$. A particle of mass m and charge q , moving in the equatorial plane of the dipole, starts at time $t = 0$ with an initial speed v_0 and an impact parameter b . Its instantaneous speed at the point of closest approach is

1. v_0
2. $0/0$
3. $v_0 + \frac{\mu q}{4\pi m b^2}$
4. $\sqrt{v_0^2 + \left(\frac{\mu q}{4\pi m b^2}\right)^2}$

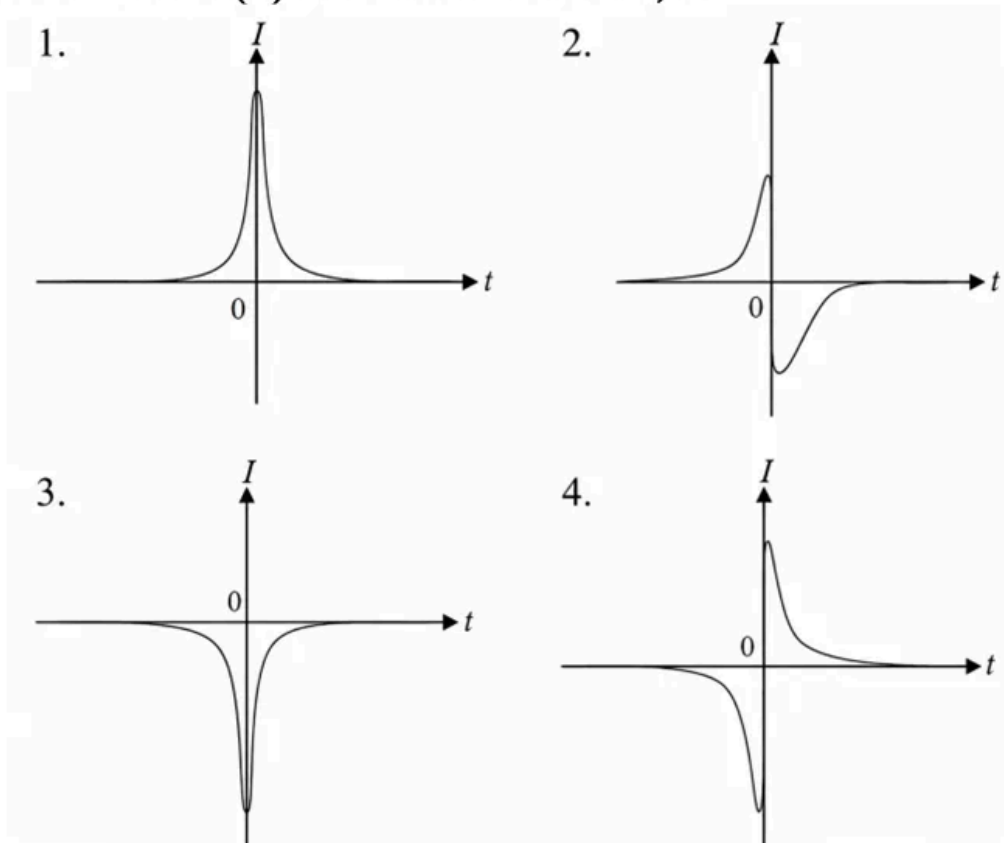
Q74. [June 2021] . 3.5 marks
 Electromagnetism > Electrodynamics

CSIR NET	2021 June	3.5M
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A conducting wire in the shape of a circle lies on the (x, y) -plane with its centre at the origin. A bar magnet moves with a constant velocity towards the wire along the z -axis (as shown in the figure below).



We take $t = 0$ to be the instant at which the midpoint of the magnet is at the centre of the wire loop and the induced current to be positive when it is counter-clockwise as viewed by the observer facing the loop and the incoming magnet. In these conventions, the best schematic representation of the induced current $I(t)$ as a function of t , is



Q75. [June 2021] . 3.5 marks

Electromagnetism > Magnetostatics

CSIR NET	2021 June	3.5M
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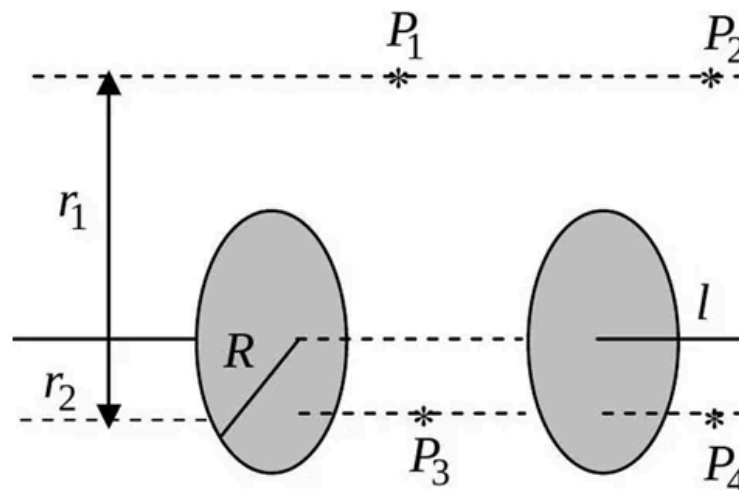
In an experiment to measure the charge to mass ratio e/m of the electron by Thomson's method, the values of the deflecting electric field and the accelerating potential are 6×10^6 N/C (newton per coulomb) and 150 V, respectively. The magnitude of the magnetic field that leads to zero deflection of the electron beam is closest to

1. 0.6 T
2. 1.2 T
3. 0.4 T
4. 0.8 T

Q76. [June 2021] . 5.0 marks
Electromagnetism > Electrodynamics

CSIR NET	2021 June	5M
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The figure below shows an ideal capacitor consisting of two parallel circular plates of radius R . Points P_1 and P_2 are at a transverse distance, $r_1 > R$ from the line joining the centers of the plates, while points P_3 and P_4 are at a transverse distance $r_2 < R$.



If $B(x)$ denotes the magnitude of the magnetic fields at these points, which of the following holds while the capacitor is charging?

- $B(P_1) < B(P_2)$ and $B(P_3) < B(P_4)$
- $B(P_1) > B(P_2)$ and $B(P_3) > B(P_4)$
- $B(P_1) = B(P_2)$ and $B(P_3) < B(P_4)$
- $B(P_1) = B(P_2)$ and $B(P_3) > B(P_4)$

Q77. [June 2021] . 5.0 marks

Electromagnetism > Electrodynamics

CSIR NET	2021 June	5M
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A perfectly conducting fluid of permittivity ϵ and permeability μ flows with a uniform velocity \vec{v} in the presence of time dependent electric and magnetic fields \vec{E} and \vec{B} , respectively, if there is a finite current density in the fluid, then

$$1. \quad \vec{\nabla} \times (\vec{v} \times \vec{B}) = \frac{\partial \vec{B}}{\partial t}$$

$$2. \quad \vec{\nabla} \times (\vec{v} \times \vec{B}) = -\frac{\partial \vec{B}}{\partial t}$$

$$3. \quad \vec{\nabla} \times (\vec{v} \times \vec{B}) = \sqrt{\epsilon\mu} \frac{\partial \vec{E}}{\partial t}$$

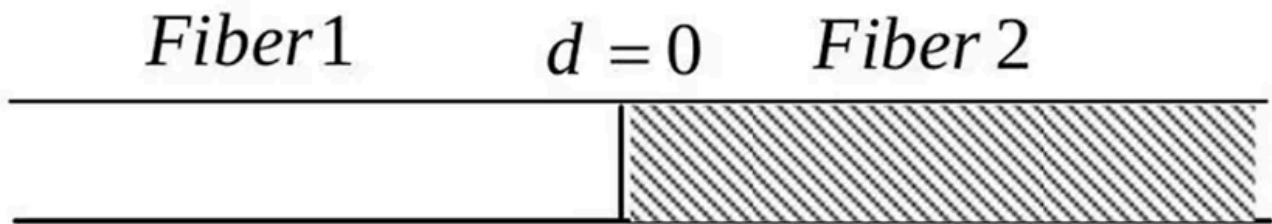
$$4. \quad \vec{\nabla} \times (\vec{v} \times \vec{B}) = -\sqrt{\epsilon\mu} \frac{\partial \vec{E}}{\partial t}$$

Q78. [June 2021] . 5.0 marks

Electromagnetism > Waveguides

CSIR NET	2021 June	5M
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A laser beam propagates from fiber 1 to fiber 2 in a cavity made up of two optical fibers (as shown in the figure). The loss factor of fiber 2 is 10 dB/km.



If $E_2(d)$ denotes the magnitude of the electric field in fiber 2 at a distance d from the interface, the ratio $E_2(0)/E_2(d)$ for $d = 10\text{km}$, is

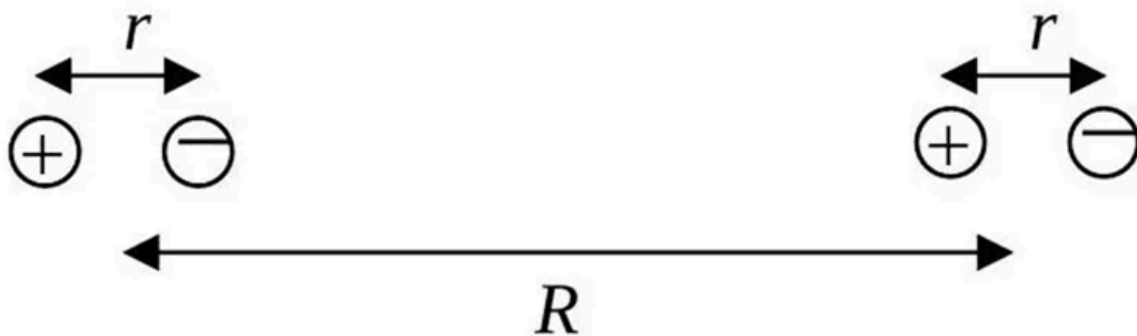
1. 10^2
2. 10^3
3. 10^5
4. 10^7

Q79. [June 2021] . 5.0 marks

Electromagnetism > Electrostatics

CSIR NET	2021 June	5M
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A linear diatomic molecule consists of two identical small electric dipoles with an equilibrium separation R , which is assumed to be a constant. Each dipole has charges $\pm q$ of mass m separated by r when the molecule is at equilibrium. Each dipole can execute simple harmonic motion of angular frequency ω .



Recall that the interaction potential between two dipoles of moments \vec{p}_1 and \vec{p}_2 , separated by $\vec{R}_{12} = R_{12}\hat{n}$ is $(\vec{p}_1 \cdot \vec{p}_2 - 3(\vec{p}_1 \cdot \hat{n})(\vec{p}_2 \cdot \hat{n})) / (4\pi\epsilon_0 R_{12}^3)$. Assume that $R \gg r$ and let $\Omega^2 = \frac{q^2}{4\pi\epsilon_0 m R^3}$. The angular frequencies of small oscillations of the diatomic molecule are

1. $\sqrt{\omega^2 + \Omega^2}$ and $\sqrt{\omega^2 - \Omega^2}$
2. $\sqrt{\omega^2 + 3\Omega^2}$ and $\sqrt{\omega^2 - 3\Omega^2}$
3. $\sqrt{\omega^2 + 4\Omega^2}$ and $\sqrt{\omega^2 - 4\Omega^2}$
4. $\sqrt{\omega^2 + 2\Omega^2}$ and $\sqrt{\omega^2 - 2\Omega^2}$

Q80. [June 2022] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2022 June	3.5M
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An electromagnetic wave is incident from vacuum normally on a planer surface of a nonmagnetic medium. If the amplitude of the electric field of the incident wave is E_0 and that of the transmitted wave is $2E_0/3$, then neglecting any loss, the refractive index of the medium is

1. 1.5
2. 2.0
3. 2.4
4. 2.7

Q81. [June 2022] . 3.5 marks

Electromagnetism > Magnetostatics

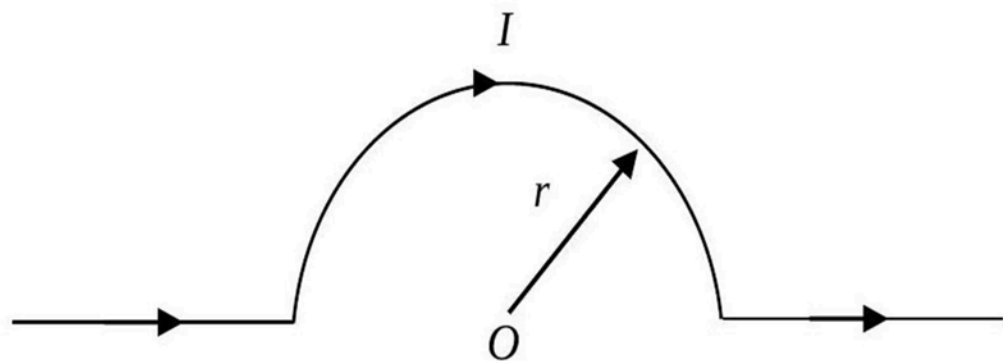
CSIR NET

2022 June

3.5M

A part of an infinitely long wire, carrying a current I , is bent in a semi-circular arc of radius r (as shown in the figure). The magnetic field at the centre O of the arc is

1. $\frac{\mu_0 I}{4r}$
2. $\frac{\mu_0 I}{4\pi r}$
3. $\frac{\mu_0 I}{2r}$
4. $\frac{\mu_0 I}{2\pi r}$

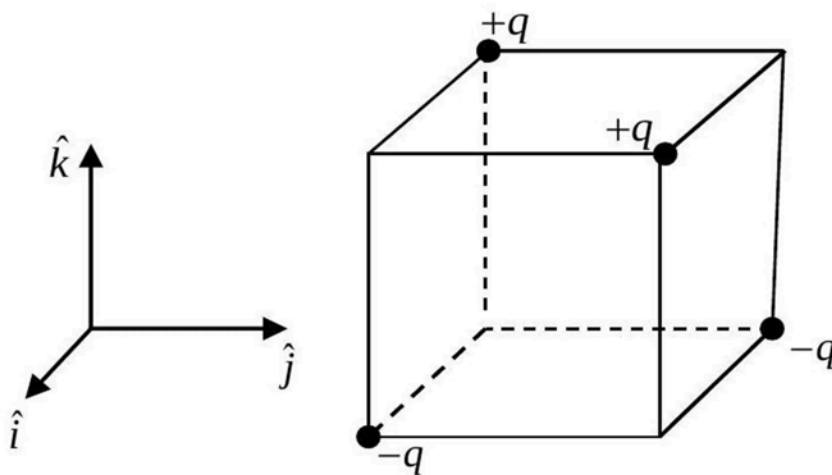


Q82. [June 2022] . 3.5 marks

Electromagnetism > Multipoles

CSIR NET	2022 June	3.5M
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Two positive and two negative charges of magnitude q are placed on the alternate vertices of a cube of side a (as shown in the figure).



The electric dipole moment of this charge configuration is

1. $-2qa\hat{k}$
2. $2qa\hat{k}$
3. $2qa(\hat{i} + \hat{j})$
4. $2qa(\hat{i} - \hat{j})$

Q83. [June 2022] . 3.5 marks

Electromagnetism > Relativistic electromagnetism

CSIR NET	2022 June	3.5M
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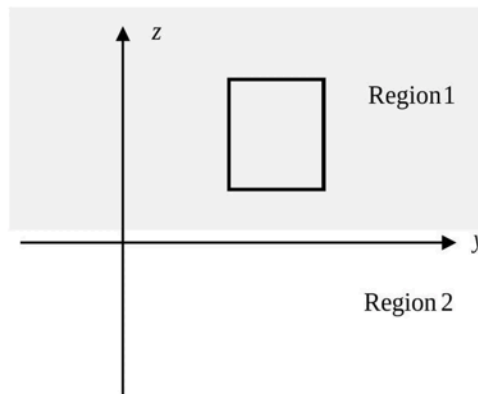
The electric and magnetic fields in an inertial frame are $\vec{E} = 3a\hat{i} - 4\hat{j}$ and $\vec{B} = \frac{5a}{c}\hat{k}$, where a is a constant. A massive charged particle is released from rest. The necessary and sufficient condition that there is an inertial frame, where the trajectory of the particle is a uniform-pitched helix, is

1. $1 < a < \sqrt{2}$
2. $-1 < a < 1$
3. $a^2 > 1$
4. $a^2 > 2$

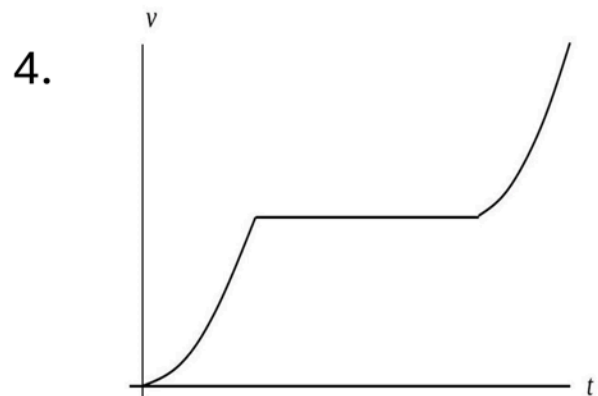
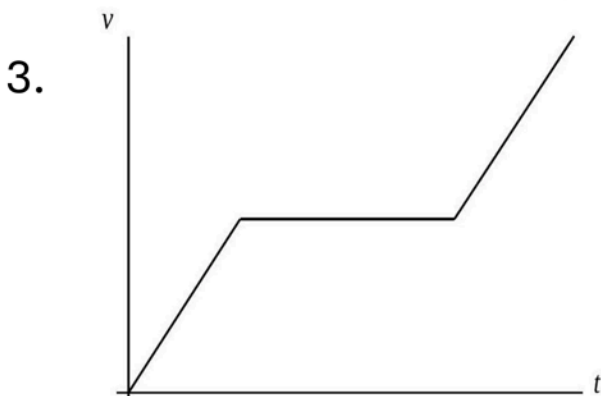
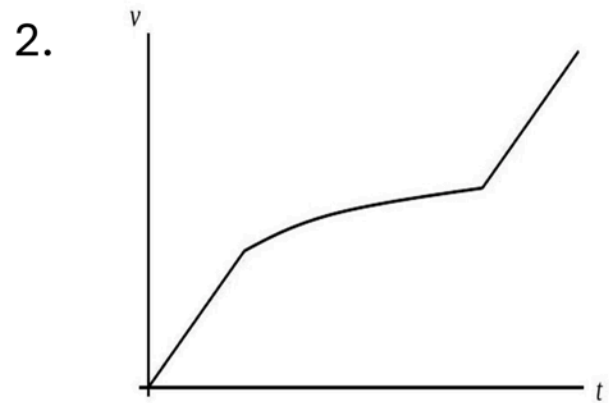
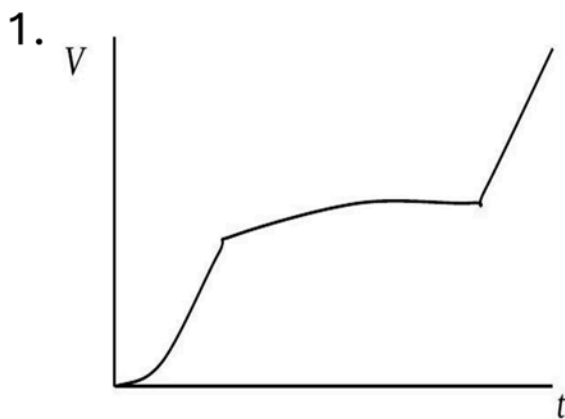
Q84. [June 2022] . 5.0 marks
 Electromagnetism > Electrodynamics

CSIR NET	2022 June	5M
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A square conducting loop in the yz -plane, falls downward under gravity along the negative z -axis. Region 1, defined by $z > 0$ has a uniform magnetic field $\vec{B} = B_0 \hat{i}$ while region 2 (defined by $z < 0$) has no magnetic field.



The time dependence of the speed $v(t)$ of the loop, as it starts to fall from well within the region 1 and passes into the region 2, is best represented by



Q85. [June 2022] . 5.0 marks

Electromagnetism > Electrostatics

CSIR NET	2022 June	5M
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Two small metallic objects are embedded in a weakly conducting medium of conductivity σ and dielectric constant ϵ . A battery connected between them leads to a potential difference V_0 . It is subsequently disconnected at time $t = 0$. The potential difference at a later time t is

1. $V_0 e^{-\frac{t\sigma}{4\epsilon}}$

2. $V_0 e^{-\frac{t\sigma}{2\epsilon}}$

3. $V_0 e^{-\frac{3t\sigma}{4\epsilon}}$

4. $V_0 e^{-\frac{t\sigma}{\epsilon}}$

Q86. [June 2022] . 5.0 marks

Electromagnetism > Magnetism in matter

CSIR NET	2022 June	5M
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A stationary magnetic dipole $\vec{m} = m\hat{k}$ is placed above an infinite surface ($z = 0$) carrying a uniform surface current density $\vec{k} = k\hat{i}$. The torque of the dipole is

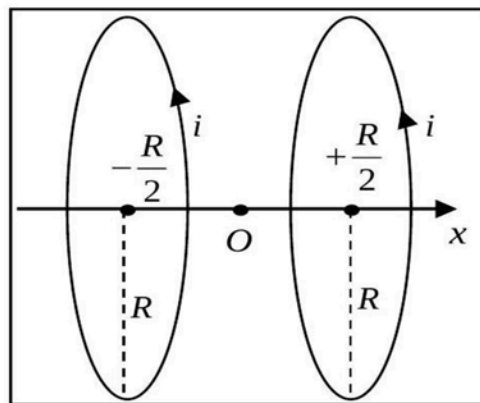
1. $\frac{\mu_0}{2} m k \hat{i}$
2. $-\frac{\mu_0}{2} m k \hat{i}$
3. $\frac{\mu_0}{2} m k \hat{j}$
4. $-\frac{\mu_0}{2} m k \hat{j}$

Q87. [June 2022] . 5.0 marks

Electromagnetism > Magnetostatics

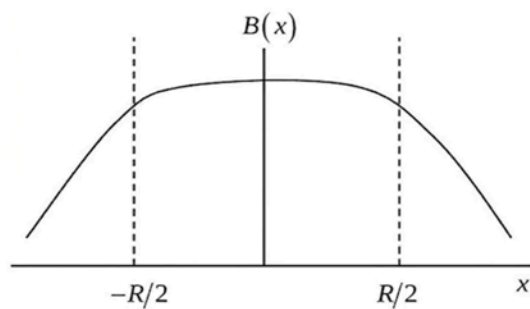
CSIR NET	2022 June	5M
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Two parallel conducting rings, both of radius R , are separated by a distance R . The planes of the rings are perpendicular to the line joining their centres, which is taken to be the x -axis.

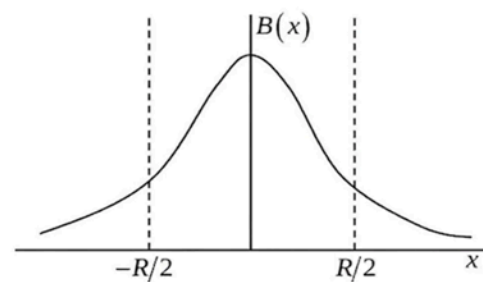


If both the rings carry the same current i along the same direction, the magnitude of the magnetic field along the x -axis is best represented by

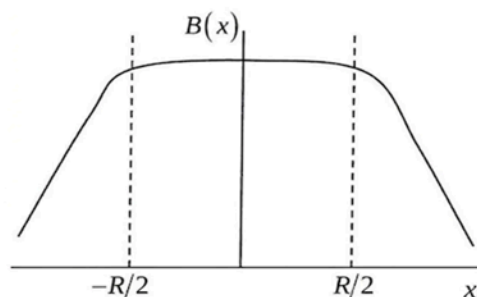
1.



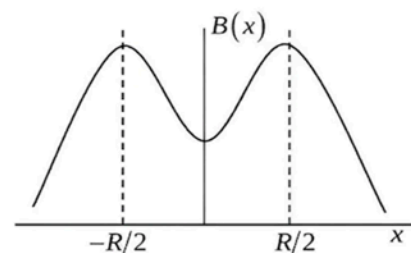
2.



3.



4.



Q88. [Dec 2023] . 3.5 marks

Electromagnetism > Magnetostatics

CSIR NET	2023 Dec	3.5 M
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A small bar magnet is placed in a magnetic field $B(\vec{r}) = B(x)\hat{z}$. The magnet is initially at rest with its magnetic moment along \hat{y} . At later times, it will undergo

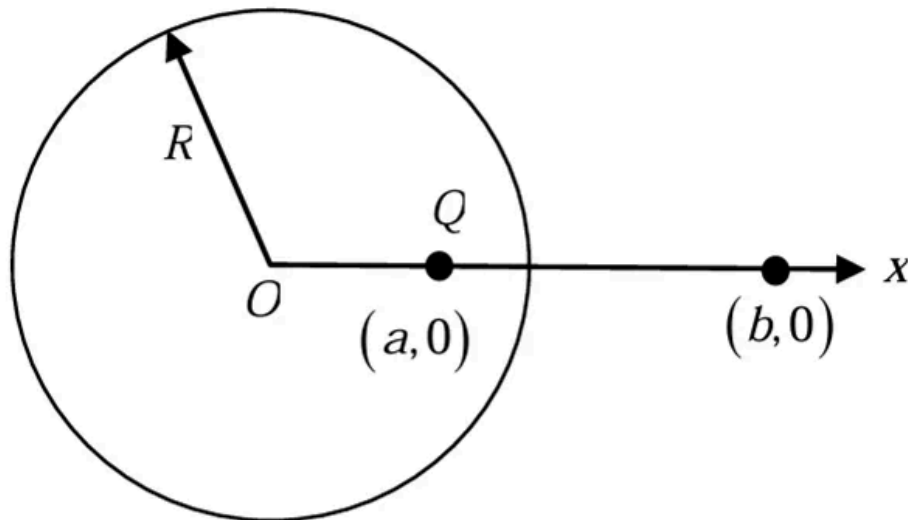
1. angular motion in the yz plane and translational motion along \hat{y}
2. angular motion in the yz plane and translational motion along \hat{x}
3. angular motion in the zx plane and translational motion along \hat{z}
4. angular motion in the xy plane and translational motion along \hat{z}

Q89. [Dec 2023] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2023 Dec	3.5 M
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A conducting shell of radius R is placed with its centre at the origin as shown below. A point charge Q is placed inside the shell at a distance a along the x -axis from the centre.



The electric field at a distance $b > R$ along the x -axis from the centre is

1. $\frac{Q}{4\pi\epsilon_0 b^2} \hat{x}$
2. $\frac{Q}{4\pi\epsilon_0} \left[\frac{1}{(b-a)^2} - \frac{aR}{(ab-R^2)^2} \right] \hat{x}$
3. $\frac{Q}{4\pi\epsilon_0} \left[\frac{1}{(b-a)^2} + \frac{aR}{(ab-R^2)^2} \right] \hat{x}$
4. $\frac{Q}{4\pi\epsilon_0} \left[\frac{1}{b^2} - \frac{R^2}{a^2 b^2} \right] \hat{x}$

Q90. [Dec 2023] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2023 Dec	3.5 M
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A one dimensional infinite long wire with uniform linear charge density λ is placed along the z-axis. The potential difference $\delta V = V(\rho + a) - V(\rho)$, between two points at radial distances $\rho + a$ and ρ from the z-axis, where $a \ll \rho$, is closest to

1. $-\frac{\lambda}{2\pi\epsilon_0} \frac{a^2}{\rho^2}$

2. $-\frac{\lambda}{2\pi\epsilon_0} \frac{a}{\rho}$

3. $\frac{\lambda}{2\pi\epsilon_0} \frac{a}{\rho}$

4. $\frac{\lambda}{2\pi\epsilon_0} \frac{a^2}{\rho^2}$

Q91. [Dec 2023] . 5.0 marks

Electromagnetism > Waveguides

CSIR NET	2023 Dec	5 M
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A transmission line has the characteristic impedance of $(50 + 1j)\Omega$ and is terminated in a load resistance of $(70 - 7j)\Omega$ (where $j^2 = -1$). The magnitude of the reflection coefficient will be closest to

1. $\frac{5}{7}$
2. $\frac{1}{2}$
3. $\frac{1}{6}$
4. $\frac{1}{7}$

Q92. [Dec 2023] . 5.0 marks

Electromagnetism > Plasma

CSIR NET	2023 Dec	5 M
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The permittivity of a medium $\varepsilon(\vec{k}, \omega)$, where ω and \vec{k} are the frequency and wavevector, respectively, has no imaginary part. For a longitudinal wave, \vec{k} is parallel to the electric field such that $\vec{k} \times \vec{E} = 0$, while for a transverse wave $\vec{k} \cdot \vec{E} = 0$. In the absence of free charges and free currents, the medium can sustain

1. longitudinal waves with \vec{k} and ω when $\varepsilon(\vec{k}, \omega) > 0$
2. transverse waves with \vec{k} and ω when $\varepsilon(\vec{k}, \omega) < 0$
3. longitudinal waves with \vec{k} and ω when $\varepsilon(\vec{k}, \omega) = 0$
4. both longitudinal and transverse waves with \vec{k} and ω when $\varepsilon(\vec{k}, \omega) > 0$

Q93. [Dec 2023] . 5.0 marks

Electromagnetism > Radiations

CSIR NET	2023 Dec	5 M
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The radius of a sphere oscillates as a function of time as $R + a \cos \omega t$, with $a < R$. It carries a charge Q uniformly distributed on its surface at all times. If P is the time averaged radiated power through a sphere of radius r , such that $r \gg R + a$ and $r \gg \frac{c}{\omega}$, then

1. $P \propto \frac{Q^2 \omega^4 a^2}{c^3}$

2. $P \propto \frac{Q^2 \omega^4}{c}$

3. $P = 0$

4. $P \propto \frac{Q^2 \omega^6 a^4}{c^5}$

Q94. [Dec 2023] . 5.0 marks

Electromagnetism > Waveguides

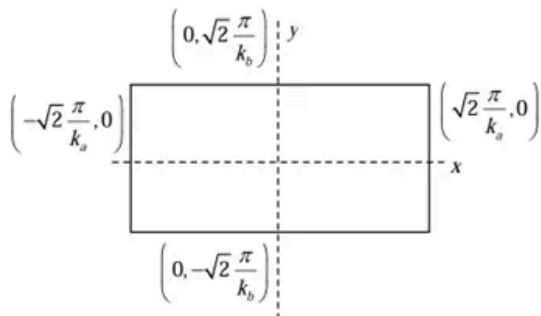
CSIR NET	2023 Dec	5 M
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A 2-dimensiona~~nl~~ resonant cavity supports a TM mode built from a function

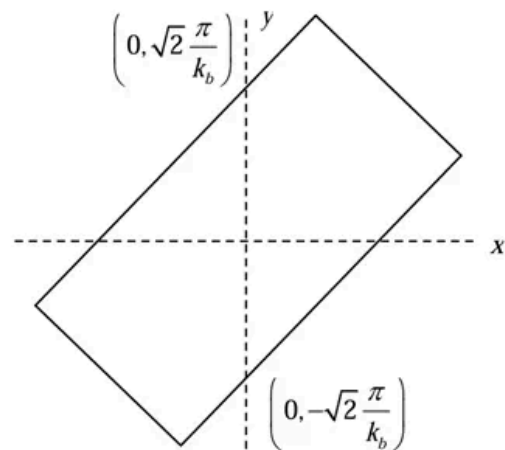
$$\psi(x, y, t) = \sin(\vec{k}_a \cdot \vec{r} - \omega t) + \sin(\vec{k}_b \cdot \vec{r} - \omega t) + \sin(\vec{k}_a \cdot \vec{r} + \omega t) + \sin(\vec{k}_b \cdot \vec{r} + \omega t)$$

where \vec{k}_a and \vec{k}_b lie in the xy -plane and make angles $\frac{\pi}{4}$ and $\frac{3\pi}{4}$ with the x -axis, respectively. If $0 < |\vec{k}_a| < |\vec{k}_b|$, then which of the following closely describes the outline of the cavity?

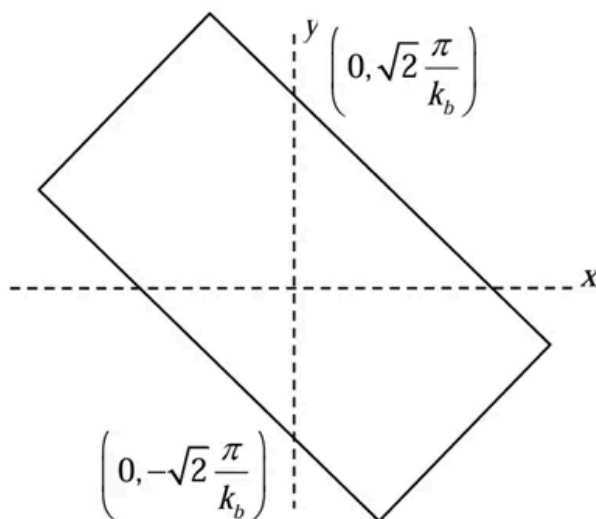
1.



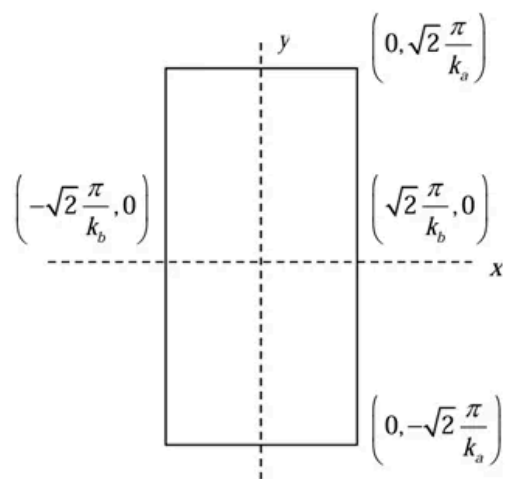
2.



3.



4.



Q95. [June 2023] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2023 June	3.5M
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A long cylindrical wire of radius R and conductivity σ , lying along the z -axis, carries a uniform axial current density I . The Poynting vector on the surface of the wire is (in the following $\hat{\rho}$ and $\hat{\phi}$ denote the unit vectors along the radial and azimuthal directions respectively)

1. $\frac{I^2 R}{2\sigma} \hat{\rho}$

2. $-\frac{I^2 R}{2\sigma} \hat{\rho}$

3. $-\frac{I^2 \pi R}{4\sigma} \hat{\phi}$

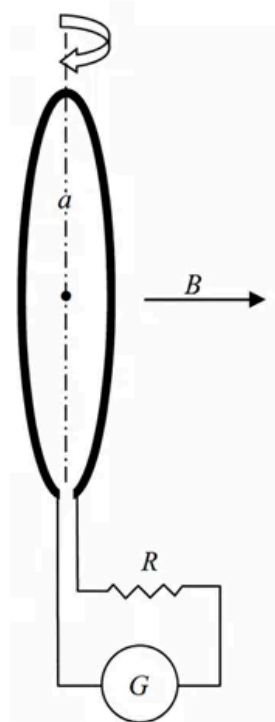
4. $\frac{I^2 \pi R}{4\sigma} \hat{\phi}$

Q96. [June 2023] . 3.5 marks

Electromagnetism > Electrodynamics

CSIR NET	2023 June	3.5M
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A small circular wire loop of radius a and number of turns N , is oriented with its axis parallel to the direction of the local magnetic field \mathbf{B} . A resistance R and a galvanometer are connected to the coil, as shown in the figure.



When the coil is flipped (i.e., the direction of its axis is reversed) the galvanometer measures the total charge Q that flows through it. If the induced emf through the coil $\mathcal{E}_F = IR$, then Q is

1. $\pi Na^2 B / (2R)$
2. $\pi Na^2 B / R$
3. $\sqrt{2} \pi Na^2 B / R$
4. $2 \pi Na^2 B / R$

Q97. [June 2023] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2023 June	3.5M
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The electric potential on the boundary of a spherical cavity of radius R , as a function of the polar angle θ , is $V_0 \cos^2 \frac{\theta}{2}$. The charge density inside the cavity is zero everywhere. The potential at a distance $R/2$ from the centre of the sphere is

1. $\frac{1}{2} V_0 \left(1 + \frac{1}{2} \cos \theta \right)$
2. $\frac{1}{2} V_0 \cos \theta$
3. $\frac{1}{2} V_0 \left(1 + \frac{1}{2} \sin \theta \right)$
4. $\frac{1}{2} V_0 \sin \theta$

Q98. [June 2023] . 5.0 marks

Electromagnetism > Relativistic electromagnetism

CSIR NET	2023 June	5M
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The charge density and current of an infinitely long perfectly conducting wire of radius a , which lies along the z -axis, as measured by a static observer are zero and a constant I , respectively. The charge density measured by an observer, who moves at a speed $v = \beta c$ parallel to the wire along the direction of the current, is

1.
$$-\frac{I\beta}{\pi a^2 c \sqrt{1-\beta^2}}$$

2.
$$-\frac{I\beta\sqrt{1-\beta^2}}{\pi a^2 c}$$

3.
$$\frac{I\beta}{\pi a^2 c \sqrt{1-\beta^2}}$$

4.
$$\frac{I\beta\sqrt{1-\beta^2}}{\pi a^2 c}$$

Q99. [June 2023] . 5.0 marks

Electromagnetism > Electrodynamics

CSIR NET	2023 June	5M
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An infinitely long solenoid of radius r_0 centred at origin which produces a time-dependent magnetic field $\frac{\alpha}{\pi r_0^2} \cos \omega t$ (where α and ω unit line charge density is placed, initially at rest, on the xy -plane with its centre on the z -axis. If $R > r_0$, the magnitude of the angular momentum of the loop is

1. $\alpha R(1 - \cos \omega t)$
2. $\alpha R \sin \omega t$
3. $\frac{1}{2} \alpha R(1 - \cos 2\omega t)$
4. $\frac{1}{2} \alpha R \sin 2\omega t$

Q100. [June 2023] . 5.0 marks

Electromagnetism > EM Waves

CSIR NET	2023 June	5M
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The electric and magnetic fields at a point due to two independent sources are $\mathbf{E}_1 = E(\alpha\hat{i} + \beta\hat{j})$, $\mathbf{B}_1 = B\hat{k}$ and $\mathbf{E}_2 = E\hat{i}$, $\mathbf{B}_2 = -2B\hat{k}$, where α, β, E and B are constants. If the Poynting vector is along $\hat{i} + \hat{j}$, then

1. $\alpha + \beta + 1 = 0$
2. $\alpha + \beta - 1 = 0$
3. $\alpha + \beta + 2 = 0$
4. $\alpha + \beta - 2 = 0$

Q101. [Dec 2024] . 3.5 marks

Electromagnetism > Magnetostatics

CSIR NET	2024 Dec	3.5M
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A sphere with uniform charge and mass density, having total charge Q and mass M , rotates about an axis through its center with angular velocity ω . The ratio of its magnetic dipole moment to its angular momentum is

1. $\frac{2Q}{M}$

2. $\frac{Q}{M}$

3. $\frac{Q}{2M}$

4. $\frac{Q}{4M}$

Q102. [Dec 2024] . 5.0 marks

Electromagnetism > Electrostatics

CSIR NET

2024 Dec

5M

A static charge distribution produces an electric field

$$\vec{E} = \frac{Q}{4\pi\epsilon_0} \frac{e^{-br}}{r^3} \vec{r},$$

where $Q, b > 0$ are constants. The charge density of the distribution is given by

1. $\frac{Q}{4\pi} \left[-\frac{b}{2r^2} \right]$
2. $\frac{Q}{4\pi} e^{-b} \left[-\frac{b}{r^2} - 4\pi\delta(\vec{r}) \right]$
3. $\frac{Q}{4\pi} e^{-br} \left[-\frac{2b}{r^2} \right]$
4. $\frac{Q}{4\pi} e^{-br} \left[-\frac{b}{r^2} + 4\pi\delta(\vec{r}) \right]$

Q103. [Dec 2024] . 5.0 marks

Electromagnetism > Electrostatics

CSIR NET	2024 Dec	5M
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Consider a spherical region of radius $\frac{R}{2}$ centered at the origin of the coordinate system. Three point charges each of magnitude Q are placed at $(0,0,R)$, $(0,R,0)$ and $(\sqrt{2}R,0,0)$. What is the magnitude of the average electric field over the spherical region due to these charges in units of

$$\frac{Q}{4\pi\epsilon_0 R^2} ?$$

1. $\frac{3}{5}$
2. 0
3. $\frac{5}{2}$
4. $\frac{3}{2}$

Q104. [Dec 2024] . 5.0 marks

Electromagnetism > Magnetostatics

CSIR NET	2024 Dec	5M
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An electron enters a region of uniform electric and magnetic fields \vec{E}_0 and \vec{B}_0 . Its velocity, \vec{E}_0 and \vec{B}_0 are mutually perpendicular to each other. Initially, E_0 is so adjusted that the electron suffers no deflection. E_0 is then switched off and the electron moves in a circular path of radius R . The speed of the electron and its charge to mass ratio would be

1. $\frac{2E_0}{B_0}, \frac{E_0}{2B_0^2 R}$

2. $\frac{2E_0}{B_0}, \frac{E_0}{B_0^2 R}$

3. $\frac{E_0}{B_0}, \frac{E_0}{B_0^2 R}$

4. $\frac{E_0}{B_0}, \frac{2E_0}{B_0^2 R}$

Q105. [June 2024] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2024 June	3.5M
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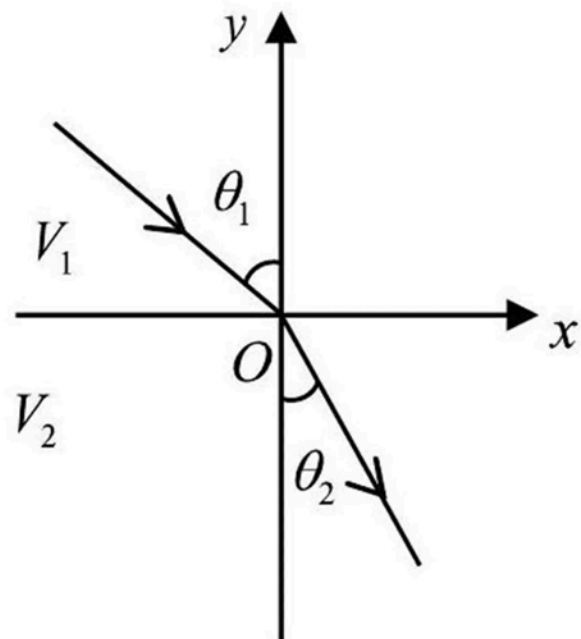
The region $y > 0$ has a constant electrostatic potential V_1 and $y < 0$ has a constant electrostatic potential $V_2 \neq V_1$. A charged particle with momentum \vec{p}_1 is incident at an angle θ_1 on the interface of the two regions (see figure below). If the particle has momentum \vec{p}_2 in the region $y < 0$, then the angle θ_2 is given by

1. $\cos^{-1} \left(\frac{p_2}{p_1} \cos \theta_1 \right)$

2. $\cos^{-1} \left(\frac{p_1}{p_2} \cos \theta_1 \right)$

3. $\sin^{-1} \left(\frac{p_2}{p_1} \sin \theta_1 \right)$

4. $\sin^{-1} \left(\frac{p_1}{p_2} \sin \theta_1 \right)$



Q106. [June 2024] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET

2024 June

3.5M

The electric field of an electromagnetic wave in free space is given by

$$\vec{E} = E_0 \sin(\omega t - k_z z) \hat{j}$$

The magnetic field \vec{B} vanishes for $t = \frac{k_z z}{\omega}$. The Poynting vector of the system is

1. $\frac{k_z}{2\mu_0\omega} E_0^2 \sin^2(\omega t - k_z z) \hat{k}$
2. $\frac{4k_z}{\mu_0\omega} E_0^2 \sin^2(\omega t - k_z z) \hat{k}$
3. $\frac{2k_z}{\mu_0\omega} E_0^2 \sin^2(\omega t - k_z z) \hat{k}$
4. $\frac{k_z}{\mu_0\omega} E_0^2 \sin^2(\omega t - k_z z) \hat{k}$

Q107. [June 2024] . 3.5 marks

Electromagnetism > Multipoles

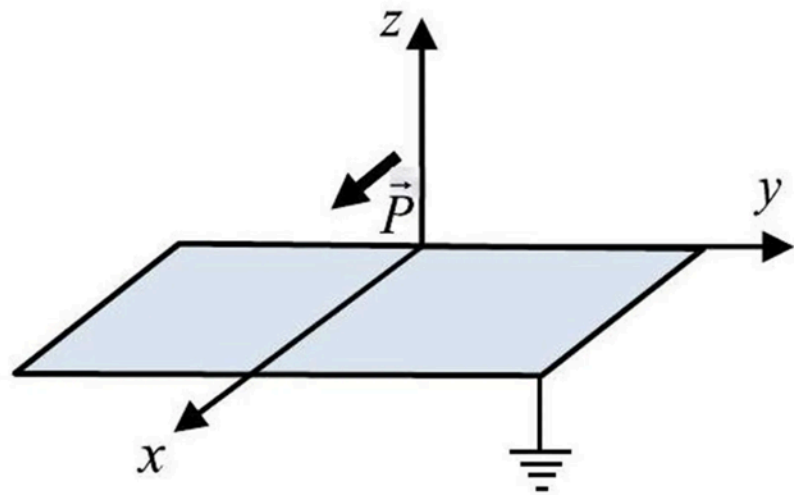
CSIR NET

2024 June

3.5M

A point electric dipole $\vec{P} = p_x \hat{i}$ is placed at a vertical distance d above a grounded infinite conducting xy plane as shown in the figure. At a point \vec{r} ($r \gg d, z > 0$) far away from the dipole, the electrostatic potential $V(r)$ varies approximately as

1. $\frac{1}{r^2}$
2. $\frac{1}{r^6}$
3. $\frac{1}{r^3}$
4. $\frac{1}{r^4}$



Q108. [June 2024] . 5.0 marks

Electromagnetism > EM Waves

CSIR NET	2024 June	5M
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In a non-magnetic material with no free charges and no free currents, the permittivity ϵ is a function of position. If \vec{E} represents the electric field and μ_0, ϵ_0 are free space permeability and permittivity respectively, which one of the following expressions is correct?

$$1. \nabla^2 E - \mu_0 \frac{\partial^2(\epsilon E)}{\partial t^2} - \frac{1}{\epsilon_0} \nabla(E \cdot \nabla \epsilon) = 0$$

$$2. \nabla^2 E - \mu_0 \frac{\partial^2(\epsilon E)}{\partial t^2} + \frac{1}{\epsilon_0} \nabla(E \cdot \nabla \epsilon) = 0$$

$$3. \nabla^2 \vec{E} - \mu_0 \frac{\partial^2(\epsilon \vec{E})}{\partial t^2} + \vec{\nabla} \left(\frac{1}{\epsilon} \vec{E} \cdot \vec{\nabla} \epsilon \right) = 0$$

$$4. \nabla^2 E - \mu_0 \frac{\partial^2(\epsilon E)}{\partial t^2} - \nabla \left(\frac{1}{\epsilon} E \cdot \nabla \epsilon \right) = 0$$

Q109. [June 2024] . 5.0 marks

Electromagnetism > EM Waves

CSIR NET	2024 June	5M
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A radio station antenna on the earth's surface radiates 50 kW power isotropically. Assume the electromagnetic waves to be sinusoidal and the ground to be a perfect absorber. Neglecting any transmission loss and effects of earth's curvature, the peak value of the magnetic field (in Tesla) detected at a distance of 100 km is closest to

1. 1.5×10^{-11}
2. 5.5×10^{-11}
3. 8.5×10^{-11}
4. 3.5×10^{-11}

Q110. [June 2024] . 5.0 marks

Electromagnetism > Magnetostatics

CSIR NET	2024 June	5M
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A particle of unit mass and unit charge is moving in a magnetic field, which varies as $\vec{B}(\vec{r}) = b_0 \vec{r}/r^3$ (b_0 is a constant) over a region far away from the origin. If \vec{L} is the instantaneous angular momentum of the particle within that region, then $d\vec{L}/dt$ is

1. $2b_0 \frac{d}{dt} \left(\frac{\vec{r}}{r} \right)$
2. $-b_0 \frac{d}{dt} \left(\frac{\vec{r}}{r} \right)$
3. $b_0 \frac{d}{dt} \left(\frac{\vec{r}}{r} \right)$
4. 0

Q111. [June 2024] . 5.0 marks

Electromagnetism > Capacitors

CSIR NET

2024 June

5M

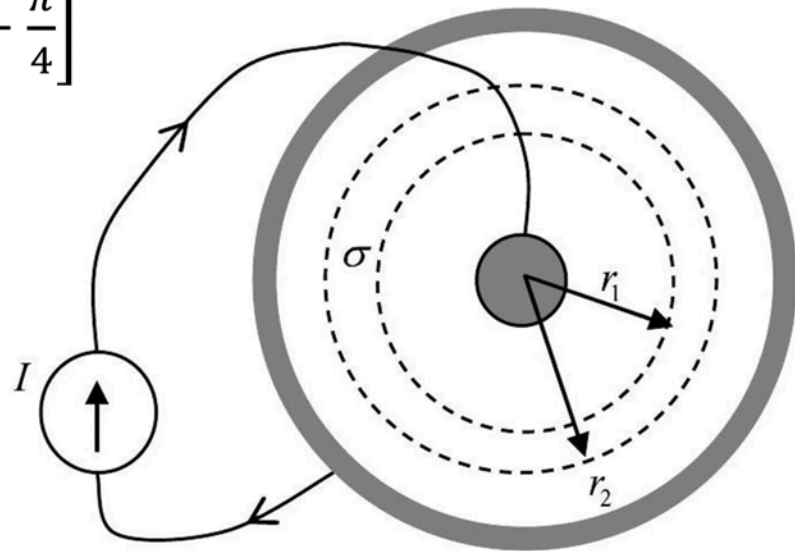
A two-dimensional sheet with a uniform sheet conductivity of σ has a central metallic point contact and a circular metal contact at the boundary as shown in the figure. If a constant current I is injected through the central contact and collected at the boundary, then the voltage difference between two points on the sheet at radius r_1 and r_2 is proportional to

1. $\frac{I}{\sigma} \left[\tan^{-1} \left(\frac{r_2}{r_1} \right) - \frac{\pi}{4} \right]$

2. $\frac{I}{\sigma} \left[\ln \left(\frac{r_2}{r_1} \right) \right]$

3. $\frac{I}{\sigma} \left(\frac{r_2 - r_1}{r_2 + r_1} \right)$

4. $\frac{I}{\sigma} \left(\frac{r_2 - r_1}{r_2 + r_1} \right)^3$



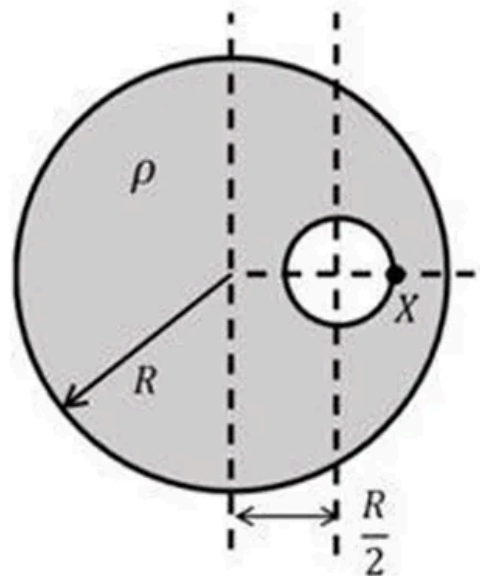
Q112. [Dec 2025] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2025 Dec	3.5M	EMT
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A solid sphere of radius R has uniform charge density ρ . A spherical volume of radius $\frac{R}{4}$ is scooped out from the sphere as shown. The electric field at the point marked X is (\hat{r} denotes the unit vector along the radially outward direction)

1. $\frac{2\rho R}{9\varepsilon_0} \hat{r}$
2. $\frac{\rho R}{6\varepsilon_0} \hat{r}$
3. $\frac{\rho R}{3\varepsilon_0} \hat{r}$
4. $\frac{\rho R}{9\varepsilon_0} \hat{r}$



Q113. [Dec 2025] . 3.5 marks

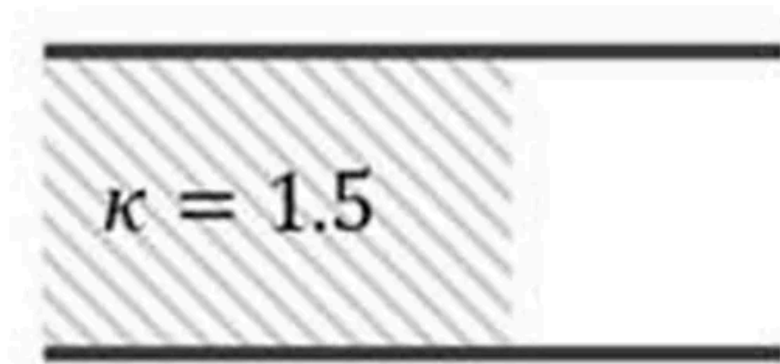
Electromagnetism > Capacitors

CSIR NET	2025 Dec	3.5M	EMT
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A fraction $\frac{2}{3}$ of the volume of a parallel plate capacitor is filled with dielectric of relative permittivity $\kappa = 1.5$ (as shown in the figure).

When the filled volume is reduced to $\frac{1}{3}$ of the total volume, the capacitance is smaller by a factor of

1. $\frac{7}{8}$
2. $\frac{5}{6}$
3. $\frac{3}{4}$
4. $\frac{2}{3}$



Q114. [Dec 2025] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2025 Dec	3.5M	EMT
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Two well separated conducting spheres (A and B) of radii 10 cm and 20 cm carry charges +30 C and -20 C respectively. When they are connected by a thin conducting wire, the final charge on A is Q_A and that on B is Q_B . The values of Q_A and Q_B respectively, are closest to

1. 6.7 C and 3.3 C
2. 2.0 C and 8.0 C
3. 3.3C and 6.7 C
4. 8.0 C and 2.0 C

Q115. [Dec 2025] . 3.5 marks

Electromagnetism > Multipoles

CSIR NET	2025 Dec	3.5M	EMT
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A circular disc of radius R is made of 2 halves (as shown in the figure), separated by a dielectric of negligible thickness (along the y axis.)

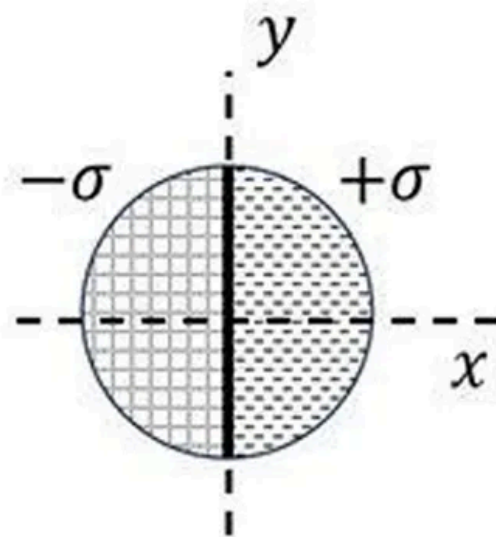
If the surface charge density on the right half is $+\sigma$ and that on the left half is $-\sigma$, the dipole moment of the disc is

$$1. P_x = 0, P_y = \frac{1}{3} \sigma R^3$$

$$2. P_x = 0, P_y = \frac{4}{3} \sigma R^3$$

$$3. P_x = \frac{1}{3} \sigma R^3, P_y = 0$$

$$4. P_x = \frac{4}{3} \sigma R^3, P_y = 0$$



Q116. [Dec 2025] . 5.0 marks

Electromagnetism > Plasma

CSIR NET	2025 Dec	5M	EMT
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Electromagnetic waves of frequency ω are incident on an electron gas, whose relaxation time is τ . Let σ_{low} and σ_{high} represent the respective electrical conductivities of the gas in low frequency ($\omega\tau \ll 1$) and high frequency ($\omega\tau \gg 1$) limits. The ratio

$(\sigma_{\text{low}} / \sigma_{\text{high}})$ is

1. inversely proportional to ω^2 .
2. directly proportional to ω^2 .
3. independent of ω .
4. directly proportional to ω .

Q117. [Dec 2025] . 5.0 marks

Electromagnetism > Electrodynamics

CSIR NET	2025 Dec	5M	EMT
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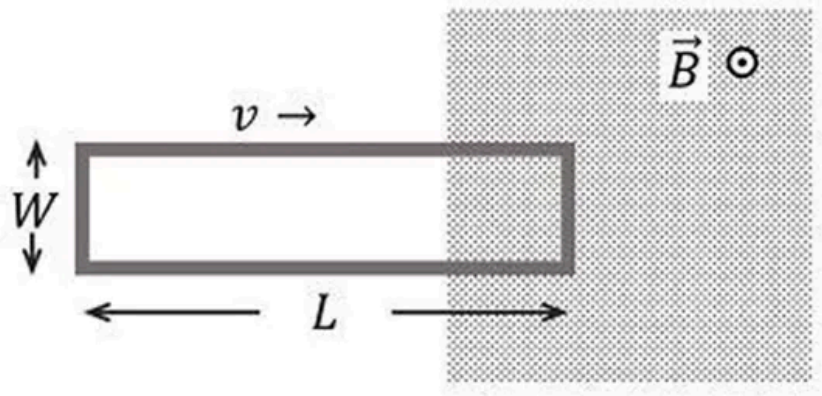
A long rectangular metallic loop of width W and length $L (\gg W)$ starts entering a region, where there is a uniform magnetic field B perpendicular to the plane of the loop. The resistance of the loop is R and its mass is M . If v_0 is the velocity of the loop just before entering the region, then neglecting the self-inductance effect, the velocity at a later time t is

$$1. v(t) = \frac{v_0}{1 + \frac{B^2 W^2}{MR} t}$$

$$2. v(t) = \frac{v_0}{1 + \left(\frac{B^2 W^2}{MR} t\right)^2}$$

$$3. v(t) = v_0 e^{-\frac{B^2 W^2}{MR} t}$$

$$4. v(t) = \frac{v_0}{1 + \ln\left(1 + \frac{B^2 W^2}{MR} t\right)}$$



Q118. [Dec 2025] . 5.0 marks

Electromagnetism > EM Waves

CSIR NET	2025 Dec	5M	EMT
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A monochromatic plane wave is incident normally from a dielectric medium A onto another dielectric medium B . The indices of refraction satisfy $n_A < n_B$. One-fourth of the incident energy is reflected back into medium A . Let \vec{E} be the resultant electric field due to the superposition of the incident wave and the reflected wave. Then, the ratio of the two time-averages $\langle \vec{E}^2 \rangle_{\min} / \langle \vec{E}^2 \rangle_{\max}$ is

1. $\frac{1}{8}$
2. $\frac{1}{9}$
3. $\frac{4}{9}$
4. $\frac{1}{4}$

Q119. [June 2025] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2025 June	3.5M	EMT
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A plane electromagnetic wave $\vec{E}_I \cos(k_z z + \omega t)$ is incident normally on a perfectly reflecting mirror in vacuum. If the permittivity of free space is ϵ_0 , the force exerted on an area A of the mirror would be

1. $A\epsilon_0 |\vec{E}_I|^2 \hat{z}$
2. $-\frac{A\epsilon_0}{2} |\vec{E}_I|^2 \hat{z}$
3. $\frac{A\epsilon_0}{2} |\vec{E}_I|^2 \hat{z}$
4. $-A\epsilon_0 |\vec{E}_I|^2 \hat{z}$

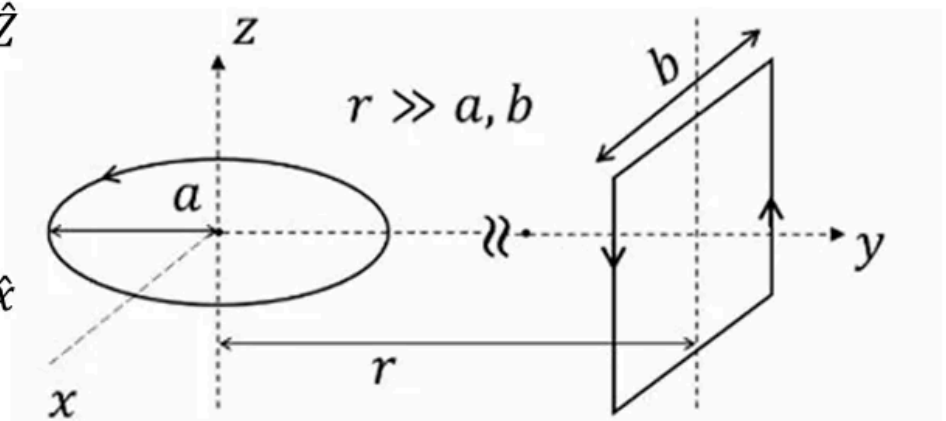
Q120. [June 2025] . 3.5 marks

Electromagnetism > Magnetostatics

CSIR NET	2025 June	3.5M	EMT
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A circular loop of radius a (in the $x - y$ plane) and a square loop of side b (in the $x-z$ plane) are kept at a distance r . Both carry current I as shown in the figure. If $r \gg a, b$, the torque exerted on the square loop by the circular loop is

1. $-\frac{\mu_0}{4\pi} \frac{1}{r^3} \pi a^2 b^2 I^2 \hat{z}$
2. 0
3. $\frac{\mu_0}{4\pi} \frac{1}{r^3} \pi a^2 b^2 I^2 \hat{x}$
4. $-\frac{\mu_0}{4\pi} \frac{1}{r^3} \pi a^2 b^2 I^2 \hat{x}$



Q121. [June 2025] . 3.5 marks

Electromagnetism > Relativistic electromagnetism

CSIR NET	2025 June	3.5M	EMT
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In a particular inertial frame, electric field \vec{E} and magnetic field \vec{B} are

$$\vec{E} = E_0 \hat{x}, \vec{B} = \frac{E_0}{2c} \hat{x}$$

Which of the following statements is true?

1. There exists an inertial frame where $\vec{E} = 0, \vec{B} \neq 0$
2. There exists no inertial frame where either $\vec{E} = 0$ or $\vec{B} = 0$
3. There exists an inertial frame where $\vec{B} = 0, \vec{E} \neq 0$
4. There exists an inertial frame where both $\vec{E} = 0$ and $\vec{B} = 0$

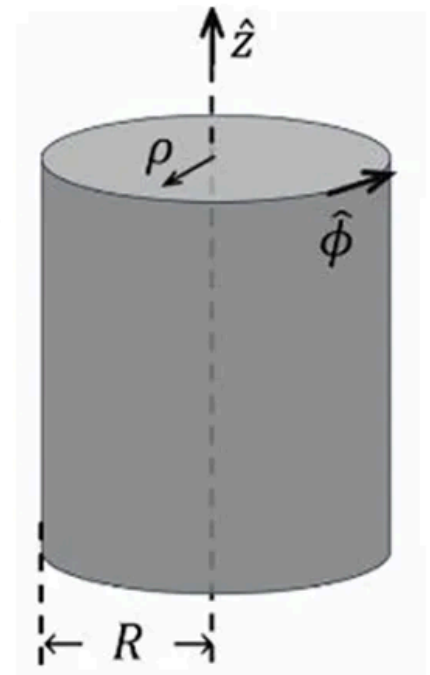
Q122. [June 2025] . 5.0 marks

Electromagnetism > Magnetism in matter

CSIR NET	2025 June	5M	EMT
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A long cylinder of radius R carries a magnetization $\vec{M} = k\rho^2\hat{\phi}$, where k is a constant, ρ is the radial distance from the axis and $\hat{\phi}$ is the azimuthal unit vector (see in the figure). The magnetic field inside and outside the cylinder would be

1. $\vec{B}_{\text{inside}} = 0, \vec{B}_{\text{outside}} = \mu_0 k \rho^2 \hat{\phi}$
2. $\vec{B}_{\text{inside}} = \mu_0 k \rho^2 \hat{\phi}, \vec{B}_{\text{outside}} = 0$
3. $\vec{B}_{\text{inside}} = \vec{B}_{\text{outside}} = \mu_0 k \rho^2 \hat{\phi}$
4. $\vec{B}_{\text{inside}} = \vec{B}_{\text{outside}} = 0$



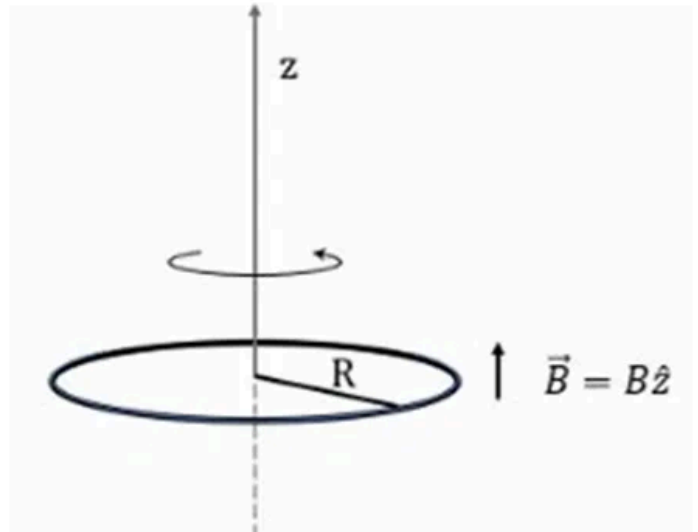
Q123. [June 2025] . 5.0 marks

Electromagnetism > Electrodynamics

CSIR NET	2025 June	5M	EMT
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A thin circular wire loop of mass M , having radius R , carries a static charge Q . The plane of the loop is held perpendicular to a uniform magnetic field \vec{B} along the z -axis passing through its centre, as shown in the figure. The loop, initially at rest, can freely rotate about the z -axis. When the magnetic field is switched off the loop starts rotating with an angular frequency

1. $\frac{QB}{M}$
2. $\frac{QB}{2M}$
3. $\frac{\pi QB}{M}$
4. $\frac{\pi QB}{2M}$



Q124. [June 2025] . 5.0 marks

Electromagnetism > Electrostatics

CSIR NET	2025 June	5M	EMT
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The charge density of the electron cloud of a hydrogen atom is given by $\rho(\vec{r}) = -\frac{e}{8\pi a^3} \exp(-r/a)$, where a is some characteristic length. The potential energy due to the interaction between the proton (sitting at the origin) and the electron cloud is given by

1. $-\frac{e^2}{2\pi\epsilon_0 a}$
2. $-\frac{e^2}{4\pi\epsilon_0 a}$
3. $-\frac{e^2}{\pi\epsilon_0 a}$
4. $-\frac{e^2}{8\pi\epsilon_0 a}$

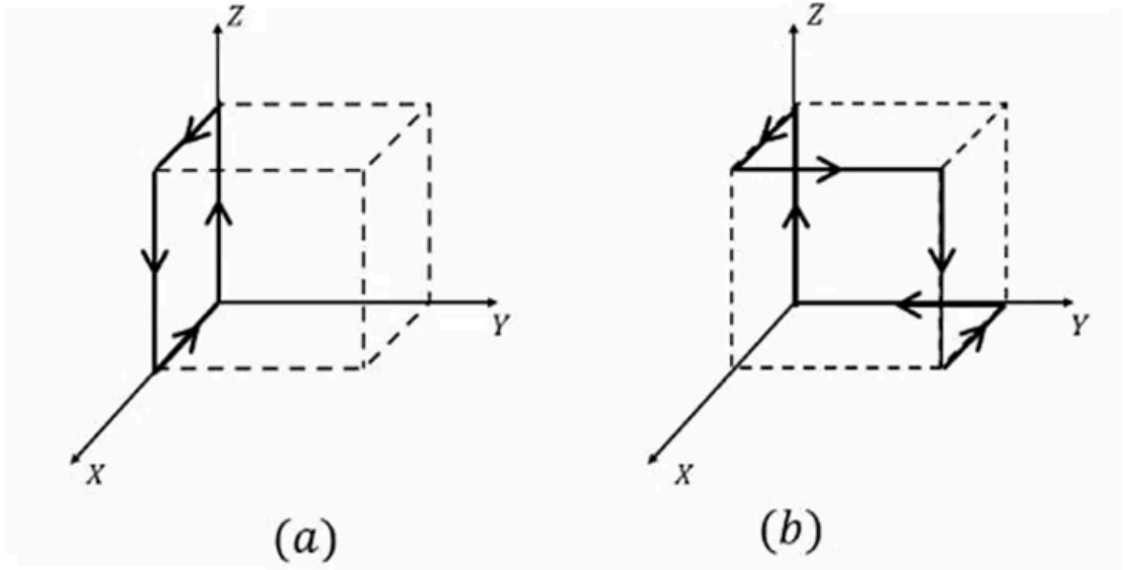
Q125. [June 2025] . 5.0 marks

Electromagnetism > Magnetostatics

CSIR NET	2025 June	5M	EMT
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Two identical cubes are shown in figures (a) and (b). The magnitude of the magnetic field at the centre of the cube in (a), produced by the currents as shown, is B_0 . The magnitude of the magnetic field at the centre of the cube in (b) will be

1. $\sqrt{3}B_0$
2. $2B_0$
3. $\frac{3}{2}B_0$
4. $\sqrt{2}B_0$



Q126. [June 2025] . 5.0 marks

Electromagnetism > Plasma

CSIR NET	2025 June	5M	EMT
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A gas of electrons (with no source of scattering) is placed in an electric field $\vec{E} = E e^{i\omega t} (\hat{i} + \hat{k})$ and a magnetic field $\vec{B} = B \hat{k}$, where E and B are constants. The frequency at which the conductivity in the z -direction, given by the ratio of the current and the electric field, both in the z -direction, diverges is

1. 0

2. $\frac{eB}{m}$

3. $-\frac{eB}{m}$

4. $\frac{eB}{2m}$

Answer Key

126 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	Electromagnetism	Electrostatics	4
Q2	Electromagnetism	Electrostatics	2
Q3	Electromagnetism	Potential Formulation	2
Q4	Electromagnetism	Magetostatics	3
Q5	Electromagnetism	Radiations	2
Q6	Electromagnetism	Plasma	1
Q7	Electromagnetism	EM Waves	4
Q8	Electromagnetism	Electrostatics	3
Q9	Electromagnetism	Magetostatics	4
Q10	Electromagnetism	Potential Formulation	4
Q11	Electromagnetism	Waveguides	1
Q12	Electromagnetism	EM Waves	1
Q13	Electromagnetism	Electrodynamics	1
Q14	Electromagnetism	Relativistic electromagnetism	4
Q15	Electromagnetism	Electrodynamics	2
Q16	Electromagnetism	Electrostatics	1
Q17	Electromagnetism	Potential Formulation	4
Q18	Electromagnetism	Electrostatics	4
Q19	Electromagnetism	Radiations	3
Q20	Electromagnetism	Electrodynamics	4
Q21	Electromagnetism	Electrostatics	3
Q22	Electromagnetism	Electrostatics	3
Q23	Electromagnetism	Capacitors	4
Q24	Electromagnetism	Electric field in matter	3
Q25	Electromagnetism	EM Waves	2
Q26	Electromagnetism	Electrodynamics	2
Q27	Electromagnetism	Electrostatics	3
Q28	Electromagnetism	Relativistic electromagnetism	3
Q29	Electromagnetism	Magetostatics	1
Q30	Electromagnetism	Waveguides	3
Q31	Electromagnetism	Multipoles	2
Q32	Electromagnetism	Capacitors	4
Q33	Electromagnetism	EM Waves	None
Q34	Electromagnetism	EM Waves	2
Q35	Electromagnetism	Relativistic electromagnetism	2
Q36	Electromagnetism	Electrodynamics	4
Q37	Electromagnetism	Electrostatics	3
Q38	Electromagnetism	Magetostatics	4
Q39	Electromagnetism	EM Waves	4
Q40	Electromagnetism	Potential Formulation	3

Answer Key (cont.)

Q. No	Subject	Topic	Answer
Q41	Electromagnetism	Radiations	None
Q42	Electromagnetism	Magetostatics	2
Q43	Electromagnetism	Electrostatics	1
Q44	Electromagnetism	Magetostatics	3
Q45	Electromagnetism	Electrostatics	3
Q46	Electromagnetism	EM Waves	1
Q47	Electromagnetism	Relativistic electromagnetism	1
Q48	Electromagnetism	Plasma	1
Q49	Electromagnetism	Magetostatics	3
Q50	Electromagnetism	Electrostatics	4
Q51	Electromagnetism	EM Waves	None
Q52	Electromagnetism	Potential Formulation	2
Q53	Electromagnetism	Magetostatics	2
Q54	Electromagnetism	Radiations	2
Q55	Electromagnetism	Waveguides	3
Q56	Electromagnetism	Electrostatics	1
Q57	Electromagnetism	Electrodynamics	4
Q58	Electromagnetism	EM Waves	2
Q59	Electromagnetism	Magetostatics	1
Q60	Electromagnetism	Radiations	1
Q61	Electromagnetism	EM Waves	2
Q62	Electromagnetism	Waveguides	4
Q63	Electromagnetism	Electric field in matter	2
Q64	Electromagnetism	Magetostatics	4
Q65	Electromagnetism	Electric field in matter	1
Q66	Electromagnetism	Relativistic electromagnetism	3
Q67	Electromagnetism	Electrostatics	2
Q68	Electromagnetism	Magetostatics	4
Q69	Electromagnetism	EM Waves	4
Q70	Electromagnetism	EM Waves	4
Q71	Electromagnetism	Relativistic electromagnetism	4
Q72	Electromagnetism	Capacitors	3
Q73	Electromagnetism	Magetostatics	1
Q74	Electromagnetism	Electrodynamics	4
Q75	Electromagnetism	Magetostatics	4
Q76	Electromagnetism	Electrodynamics	3
Q77	Electromagnetism	Electrodynamics	1
Q78	Electromagnetism	Waveguides	3
Q79	Electromagnetism	Electrostatics	3
Q80	Electromagnetism	EM Waves	2
Q81	Electromagnetism	Magetostatics	1

Answer Key (cont.)

Q. No	Subject	Topic	Answer
Q82	Electromagnetism	Multipoles	2
Q83	Electromagnetism	Relativistic electromagnetism	3
Q84	Electromagnetism	Electrodynamics	2
Q85	Electromagnetism	Electrostatics	4
Q86	Electromagnetism	Magnetism in matter	1
Q87	Electromagnetism	Magetostatics	1
Q88	Electromagnetism	Magetostatics	2
Q89	Electromagnetism	Electrostatics	1
Q90	Electromagnetism	Electrostatics	2
Q91	Electromagnetism	Waveguides	3
Q92	Electromagnetism	Plasma	3
Q93	Electromagnetism	Radiations	3
Q94	Electromagnetism	Waveguides	2
Q95	Electromagnetism	EM Waves	2
Q96	Electromagnetism	Electrodynamics	4
Q97	Electromagnetism	Electrostatics	1
Q98	Electromagnetism	Relativistic electromagnetism	1
Q99	Electromagnetism	Electrodynamics	1
Q100	Electromagnetism	EM Waves	1
Q101	Electromagnetism	Magetostatics	3
Q102	Electromagnetism	Electrostatics	4
Q103	Electromagnetism	Electrostatics	4
Q104	Electromagnetism	Magetostatics	3
Q105	Electromagnetism	EM Waves	4
Q106	Electromagnetism	EM Waves	4
Q107	Electromagnetism	Multipoles	3
Q108	Electromagnetism	EM Waves	3
Q109	Electromagnetism	EM Waves	2
Q110	Electromagnetism	Magetostatics	3
Q111	Electromagnetism	Capacitors	2
Q112	Electromagnetism	Electrostatics	2
Q113	Electromagnetism	Capacitors	1
Q114	Electromagnetism	Electrostatics	3
Q115	Electromagnetism	Multipoles	4
Q116	Electromagnetism	Plasma	4
Q117	Electromagnetism	Electrodynamics	3
Q118	Electromagnetism	EM Waves	2
Q119	Electromagnetism	EM Waves	4
Q120	Electromagnetism	Magetostatics	4
Q121	Electromagnetism	Relativistic electromagnetism	2
Q122	Electromagnetism	Magnetism in matter	2

Answer Key (cont.)

Q. No	Subject	Topic	Answer
Q123	Electromagnetism	Electrodynamics	2
Q124	Electromagnetism	Electrostatics	4
Q125	Electromagnetism	Magetostatics	1
Q126	Electromagnetism	Plasma	1

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