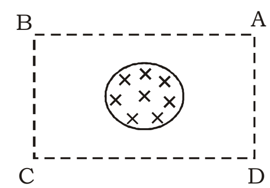
1. A region contains magnetic field that has no $\hat{\phi}$ component as described in cylindrical coordinates. The s-component of the magnetic field has a value B_0 at $s=a$. A circular wire loop is at $z=0, s=a$ at time $t=0$ and moves along the z-axis with a uniform velocity v. Find the emf produced in the loop due to its motion.
2. A conducting spherical shell of radius R rotates about a diameter, taken as the z-axis, with an angular velocity ω in a uniform magnetic field $B=B_0\hat{k}$. Calculate the emf developed between the points with $z=0$ and $z=R$.

3. An infinite surface current confined in x–y plane is given by $\mathbf{K}=K_0(1+\alpha t)\hat{\mathrm{i}}$. (a) Find The vector potential due to this current. (b) Using this vector potential, find the induced electric field everywhere.



4. A magnetic field $\mathbf{B}=B_0\cos\omega t\,\hat{k}$ exists in a long cylindrical region $s\le a$. Consider a rectangular path ABCD in the $x-y$ plane, with the center of the rectangle at the origin. Let the length $AB=l$ and $BC=b$.

(a) Find $\int_A^B \mathbf{E}\bullet\mathbf{dl}$.

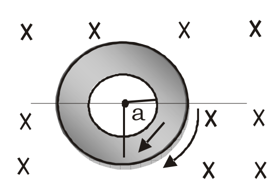
(b) Suppose a uniform frame made of copper is placed to fit ABCD. What is the value of $\int_A^B \mathbf{E}\bullet\mathbf{dl}$. Why is it different from that found in the previous problem?

(c) Will $\int \mathbf{E}\cdot\mathbf{dl}$ other the rectangle ABCD same or different in the two cases?

More problems

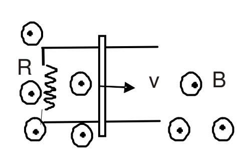
1. A conducting rod moves in a uniform magnetic field with a constant velocity of 3 cm/s. The length of the rod, the velocity and the field are mutually perpendicular. By what fraction the magnetic field in the rod differ from that outside the rod at a large distance?

[Ans. 10^{-20}]



2. A conducting annular ring of inner and outer radii a and b rotates at a constant angular velocity ω about its axis. A uniform magnetic field B exists perpendicular to the plane of the ring. Find the electric field in the ring.

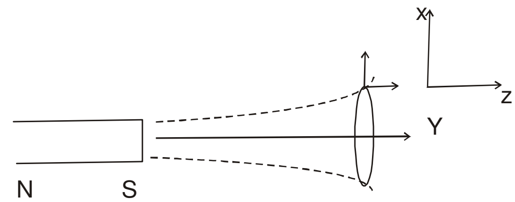
[Ans. Taking z-axis along the axis, the field is $\mathbf{E}=-\omega sB\hat{s}$ in cylindrical coordinates]



3. A conducting rod of mass M slides on two parallel horizontal rails, connected at one end by a resistance R. The rails and the rod are assumed to have no resistance and no friction. At $t=0$, the rod has a velocity v_0. (a)

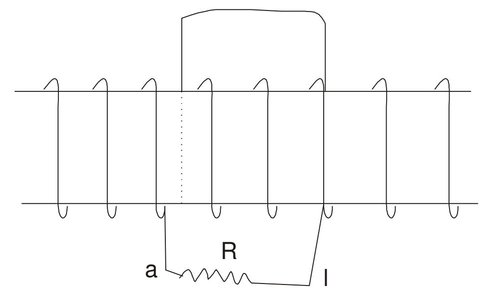
Find the velocity of the rod at time t (b) Find the power p dissipated in the resister at time t. (c) Calculate $\int_0^\infty P dt$. [Ans. (a) $v_0 e^{-\frac{B^2l^2}{mR}t}$ (b) $\frac{B^2l^2v_0^2}{R}$ (c) $\frac{1}{2}mv_0^2$]

4. A magnet NS is placed along the axis of a circular conducting ring of radius a and total resistance R. The ring itself is moving along its axis which is taken as the z-axis. At an instant the velocity of the ring is v_o and the magnetic field at the periphery of the ring is $\mathbf{B} = B_1\hat{s} + B_2\hat{k}$. Find the induced current.



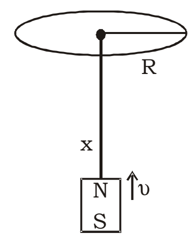
[Ans. $\frac{2\pi v_0 B_1 a}{R}$]

5. A circular coil of radius a having n turns is located in the field of an electromagnet. The field is perpendicular to the coil and its strength B_o is uniform over the area. The coil is connected to an external resister. The total resistance of the circuit is R. Find the total charge Q passing through the resister if the electromagnet is turned off.



[Ans. $\frac{n\pi G^2 B_0}{R}$]

6. A short magnet having magnetic moment M is moving at a constant velocity v along its axis. A conducting ring of radius R is kept coaxially with the magnet. Consider the situation in which the distance x between the ring and the magnet is much larger than R and find the emf induced in the ring.



[Ans. $\frac{3\mu_0 R^2 M}{2x^4}v$]