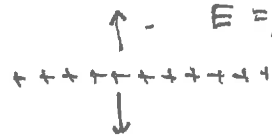
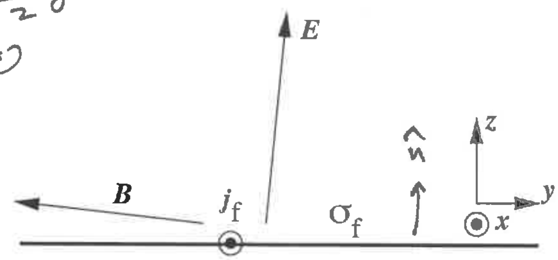
$E = \frac{\sigma}{2\varepsilon_0} = 5000\ \mathrm{V/m}$



The reason for these sketches is so you have an idea what to expect

The $z = 0$ plane is the boundary between two materials: the region of space with $z > 0$ is vacuum, the region with $z < 0$ has $\epsilon = 4\epsilon_0$ and $\mu = 1000\mu_0$. The boundary carries a surface charge density of $\sigma_f = 8.85 \times 10^{-8}\ \mathrm{C/m^2}$ and a surface current (flowing in the x direction) of $j_f = 10^3\ \mathrm{A/m}$. On the vacuum side of the boundary $\vec{E} = 10^3\hat{j} + 10^4\hat{k}$ V/m, and $\vec{B} = -10^{-4}\hat{j} + 10^{-5}\hat{k}$ T. Start by making a sketch showing the directions of the $\vec{E}$ (on both sides) that would result from σ_f in a vacuum. Show on your sketch the direction you are taking for the boundary's normal. Make a sketch showing the direction of $\vec{B}$ (on both sides) that would result from $\vec{j}_f$ in a vacuum. Show on your sketch the direction you are taking for the boundary's tangent. Now find $\vec{E}$ and $\vec{B}$ inside the material. ($\epsilon_0 = 8.85 \times 10^{-12}\ \ \mathrm{C^2/(N\cdot m^2)}$ $\mu_0 = 4\pi \times 10^{-7}\ \ \mathrm{N/A^2}$)

$B = \frac{\mu_0}{2} j = 2\pi \cdot 10^{-7} \cdot 10^{3} = 2\pi \times 10^{-4} = 6.28 \times 10^{-4}\ \mathrm{T}$



E_t unchanged so $E_y = 10^3$ V/m

$D_z^+ - D_z^- = \sigma_f \Rightarrow D_z^- = D_z^+ - \sigma_f = \varepsilon_0 \cdot 10^4 - 8.85 \times 10^{-8}$

$= 0 = \varepsilon E_z^-$

$\vec{E}^- = 10^3\hat{j} + 0$

B_x^+ & H_x^+ zero — so then B_x^- & H_x^- are zero.

$H_y^- - H_y^+ = j_f$; $H_y^- = H_y^+ + j_f = \frac{-10^{-4}}{\mu_0} + 10^3 = \left(1 - \frac{1}{4\pi}\right)10^3$

$B_y^- = 1000\mu_0 H_y^- = 10^6 (4\pi - 1)\, 10^{-7} = (4\pi-1)10^{-1}\ \mathrm{T} = 1.16\ \mathrm{T}$

$B_z^- = B_z^+ = 10^{-5}\ \mathrm{T}$

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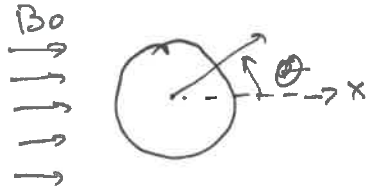
9-11



problem is even about x axis θ

inside : no $\frac{1}{r^n}$

outside : $-H_0 \underset{r\cos\theta}{x}$. otherwise no r^n

$$\left.\begin{aligned} \phi_{in} &= \sum A_n r^n \cos n\theta \\ \phi_{out} &= -H_0 r\cos\theta + \sum c_n/r^n \cos(n\theta) \end{aligned}\right]$$

problem & experience suggests only need n=1

$$\phi_{in} = A_1 r\cos\theta$$

$$\phi_{out} = -H_0 r\cos\theta + \frac{c_1}{r}\cos\theta$$

H_t continuous $\Rightarrow$ $\phi_{in} = \phi_{out} \Big|_{r=R}$ $\Rightarrow A_1 R = -H_0 R + \frac{c_1}{R}$

or $A_1 = -H_0 + \frac{c_1}{R^2}$

B_r continuous $\Rightarrow$ $K\partial_r \phi_{in} = \partial_r \phi_{out}\Big|_{r=R}$ $\Rightarrow K A_1 = -H_0 - \frac{c_1}{R^2}$

$$A_1 = -H_0 + (-H_0 - KA_1)$$

$(K+1)A_1 = -2H_0 \Rightarrow A_1 = \frac{-2}{K+1}H_0$

$A_1 = \frac{-2}{K+1}H_0 = -H_0 + \frac{c_1}{R^2} \Rightarrow \frac{K-1}{K+1}H_0 = \frac{c_1}{R^2}$

check: if $K=1$ $c_1 = 0$ & $A_1 = -H_0$ ie no effect

$H_{inside} = -\nabla\phi_{inside} = \frac{2}{K+1}H_0 \Rightarrow B_{inside} = \frac{2K}{K+1}\underbrace{\mu_0 H_0}_{B_{outside}}$

remark: if $K\to\infty$; cylinder has "sucked in" enough flux to double the B inside cf. outside.