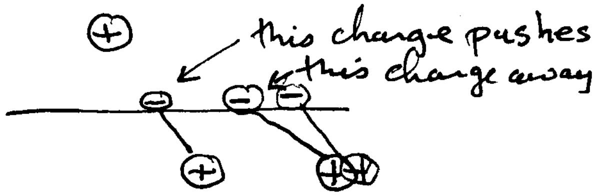


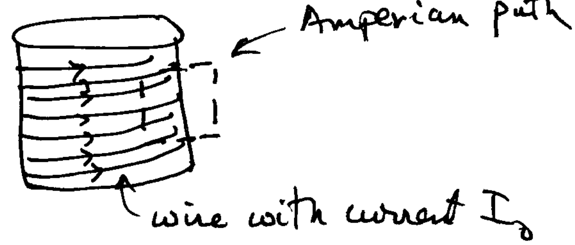
7. A point charge is near an semi-infinite dielectric surface. Why is the net electric field not radial? Use just a few sentences and no symbols.

$\vec{E}_{pt.}$ induces dipoles $\vec{p}$ in the dielectric. These dipoles generate $\vec{E}_{dipole}$ which modifies (positive feedback) $\vec{E}$ seen by the other dipoles, causing the dipoles to orient not along $\vec{E}_{pt}$.

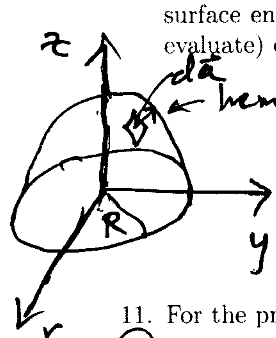
8. Charge of density ρ forms a sphere of radius R. It is rotated at angular frequency $\vec{\omega}$ along the z axis in the presence of a $\vec{B}$. Write a detailed expression for $\vec{J}d\tau$.

$$\vec{J} = \rho\vec{v} = \rho\,\vec{\omega}\times\vec{r} = \rho\omega r\sin\theta\,\hat{\phi}$$

9. What path would you apply Ampere's law to for a long solenoid driven by constant current. Sketch the solenoid and path.



10. An infinite straight wire of radius R contains $\vec{J} = J_0\hat{z}$. This generates $\vec{B} = \frac{\mu_0 J_0}{2} r\hat{\phi}$ inside the wire. I want to apply Stokes theorem to a circle around the wire centered at the origin in the x-y plane. The surface enclosing this circle is a hemisphere of radius R. Write an expression for $\nabla\times\vec{B}\cdot d\vec{a}$ (don't evaluate) on this hemisphere.



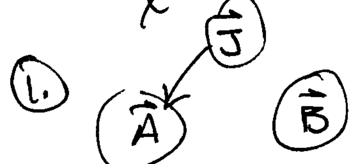
$$d\vec{a} = r^2\sin\theta\, d\theta\, d\phi\,\hat{r} \qquad \nabla\times\vec{B} = \mu_0\vec{J} = \mu_0 J_0\hat{z}$$

$$\nabla\times\vec{B}\cdot d\vec{a} = \mu_0 J_0 r^2\sin\theta\, d\theta\, d\phi\;\hat{z}\cdot\hat{r}$$

$$\hat{z}\cdot\hat{r} = \hat{z}\cdot(\sin\theta\cos\phi\,\hat{x} + \sin\theta\sin\phi\,\hat{y} + \cos\theta\,\hat{z}) = \cos\theta$$

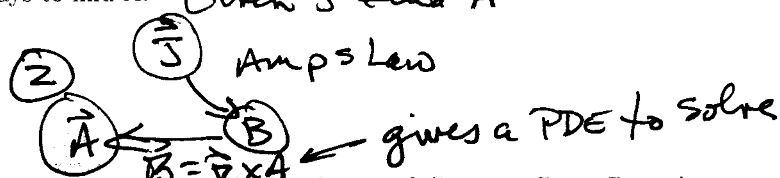
11. For the previous problem outline two ways to find $\vec{A}$. Given $\vec{J}$ find $\vec{A}$

1.

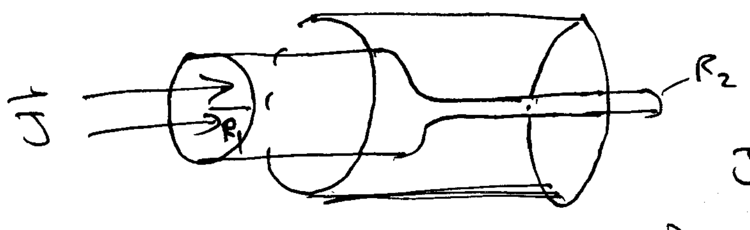


$$\vec{A} = \frac{\mu_0}{4\pi}\int\frac{\vec{J}\,d\tau'}{r}$$

2.



12. A long cylindrical wire of diameter R_1 tapers down to a cylindrical wire of diameter $R_2 < R_1$ and then continues. Within the wire, charge flows at constant density ρ_0. In the magneto-static case sketch below the wire and a surface through which you would apply conservation of charge to easily determine the relative speeds of the charges in the two wire segments and write that relation.



$$\oint\vec{J}\cdot d\vec{a} = -\frac{\partial Q_{encl}}{\partial t} = 0$$

$$J_1 A_1 = J_2 A_2$$

$$\cancel{\rho} v_1 \cancel{\pi} R_1^2 = \cancel{\rho} v_2 \cancel{\pi} R_2^2$$

$$\boxed{v_1 R_1^2 = v_2 R_2^2}$$