

Name KEY

Quiz 11
PH361

$$\begin{aligned} \vec{p} &= \int \vec{r}' \rho(r') d\tau' \\ \text{solenoid } B &= \mu_0 n I \\ \vec{F} &= (\vec{p} \cdot \nabla) \vec{E} \\ E &= \frac{1}{4\pi\epsilon_0} \frac{1}{r^3} (3\vec{p} \cdot \hat{r} \hat{r} - \vec{p}) \\ \nabla \frac{1}{r} &= \frac{\partial}{\partial r} \hat{r} + \frac{1}{r} \frac{\partial}{\partial \theta} \hat{\theta} + \frac{1}{r \sin \theta} \frac{\partial}{\partial \phi} \hat{\phi} \\ \hat{r} &= \sin \theta \cos \phi \hat{x} + \sin \theta \sin \phi \hat{y} + \cos \theta \hat{z} \\ \hat{\theta} &= \cos \theta \cos \phi \hat{x} + \cos \theta \sin \phi \hat{y} - \sin \theta \hat{z} \\ \hat{\phi} &= -\sin \phi \hat{x} + \cos \phi \hat{y} \\ \vec{D} &= \epsilon_0 \vec{E} + \vec{P} \\ \vec{D} &= \epsilon \vec{E} \\ \vec{F} &= q \vec{v} \times \vec{B} \\ d\vec{F} &= I d\vec{l} \times \vec{B} = \vec{K} \times \vec{B} da = \vec{J} \times \vec{B} dr \\ d\vec{A} &= \frac{\mu_0}{4\pi} \int \frac{I}{|\vec{r} - \vec{r}'|} d\vec{l}' = \frac{\mu_0}{4\pi} \int \frac{J(\vec{r}')}{|\vec{r} - \vec{r}'|} d\tau' \end{aligned}$$

1. A long solenoid of radius a , carrying current n turns per unit length, is looped by a wire with resistance R . The current I in the solenoid is constant but the solenoid is pulled out of the loop, turned around, and reinserted. Derive an expression for the total charge which passes through the resistor.

$$\begin{aligned} I &= \frac{dQ}{dt} = \frac{\mathcal{E}}{R} = -\frac{1}{R} \frac{d\Phi_B}{dt} \Rightarrow |dQ| = \frac{1}{R} \Delta \Phi_B \\ \Phi_{\text{initial}} &= \int \vec{B} \cdot d\vec{a} = B \int da = \mu_0 n I_0 \pi a^2 \\ &\quad \mu_0 n I_0 \\ I_{\text{final}} &= -I_{\text{initial}} \Rightarrow \Delta \Phi = 2\Phi_{\text{initial}} \end{aligned}$$