

Name

KEY

Quiz 13
PH361

$$\vec{p} = \int \vec{r}' \rho(r') d\tau'$$

solenoid $B = \mu_0 n I$

$$\vec{F} = (\vec{p} \cdot \nabla) \vec{E}$$

$$E = \frac{1}{4\pi\epsilon_0} \frac{1}{r^3} (3\vec{p} \cdot \hat{r} \hat{r} - \vec{p})$$

$$\nabla t = \frac{\partial t}{\partial r} \hat{r} + \frac{1}{r} \frac{\partial t}{\partial \theta} \hat{\theta} + \frac{1}{r \sin \theta} \frac{\partial t}{\partial \phi} \hat{\phi}$$

$$\hat{r} = \sin \theta \cos \phi \hat{x} + \sin \theta \sin \phi \hat{y} + \cos \theta \hat{z}$$

$$\hat{\theta} = \cos \theta \cos \phi \hat{x} + \cos \theta \sin \phi \hat{y} - \sin \theta \hat{z}$$

$$\hat{\phi} = -\sin \phi \hat{x} + \cos \phi \hat{y}$$

$$\vec{D} = \epsilon_0 \vec{E} + \vec{P}$$

$$\vec{D} = \epsilon \vec{E}$$

$$\vec{F} = q \vec{v} \times \vec{B}$$

$$d\vec{F} = I d\vec{l} \times \vec{B} = \vec{K} \times \vec{B} da = \vec{J} \times \vec{B} d\tau$$

$$d\vec{A} = \frac{\mu_0}{4\pi} \int \frac{1}{|\vec{r} - \vec{r}'|} d\vec{l}' = \frac{\mu_0}{4\pi} \int \frac{J(\vec{r}')}{|\vec{r} - \vec{r}'|} d\tau'$$

$$W = \frac{1}{2\mu_0} \int_{\text{all space}} B^2 d\tau$$

1. Find the energy stored in a toroidal coil with rectangular cross section (inner radius a , outer radius b , and height h). Note $B = \frac{\mu_0 n I}{2\pi s}$.

$$W = \frac{1}{2\mu_0} \int B^2 d\tau = \frac{1}{2\mu_0} \frac{\mu_0^2 n^2 I^2}{4\pi^2} \int_a^b \int_0^{2\pi} \int_0^h \frac{1}{s} h s d\phi ds$$

$$= \frac{\mu_0 n^2 I^2}{8\pi^2} h 2\pi \ln\left(\frac{b}{a}\right)$$