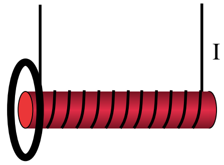
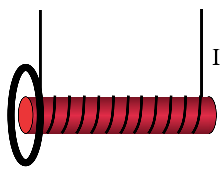
Problem 20.64

A 5 cm aluminum ring with resistance 3x10^(-4) ohms is placed around a 1000 *turn per meter* solenoid. If the current in the solenoid increases at a constant rate of 270 Amps/second, what is the induced current in the ring? Assume the solenoid's magnetic field at its end is half its magnetic field of at it's center, where "n" is the number of turns per meter in the coil. $\mu_o nI$



At an given instant, the end of the solenoid is producing a B field equal to:

$$B = \left(\tfrac{1}{2}\right)\mu_o nI$$



Remember that the changing B field, which is producing the EMF, is being generated by a changing current whose RATE OF CHANGE we know (it's 270 amps per second). With this, we can write:

$$\varepsilon_{ind} = -N\frac{\Delta\phi_B}{\Delta t}$$

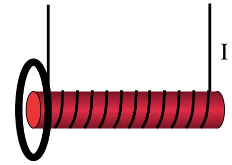
$$\varepsilon_{ind} = -N\frac{A\Delta B}{\Delta t}$$

$$\varepsilon_{ind} = -N\frac{A_{coil}\Delta\left(.5\mu_o nI - 0\right)}{\Delta t}$$

$$\varepsilon_{ind} = -NA\left(.5\mu_o n\right)\frac{\Delta I}{\Delta t}$$

$$= -(1)\left(\pi(.03)^2\right)\left[.5\left(4\pi x10^{-7}\right)(1000)\right](270 \text{ A/s})$$

$$= 4.8x10^{-4} \text{ volts}$$



With the EMF, we can use Ohm's Law to determine the induced current:

$$\varepsilon_{ind} = iR$$

$$\Rightarrow \quad i = \frac{\varepsilon_{ind}}{R}$$

$$\Rightarrow \quad i = \frac{\left(4.8x10^{-4} \text{ volts}\right)}{\left(3x10^{-4}\ \Omega\right)}$$

$$\Rightarrow \quad i = 1.6 \text{ amps}$$