Question #75233, Physics / Electromagnetism |

You have a 1.0-m-long copper wire. You want to make an N-turn current loop that generates a 1.0 mT magnetic field at the center when the current is 1.0 A. You must use the entire wire. 'What will be the diameter of your coil?

Need to calculate:

d - ?

$l = 1.0\ m$

$B = 1.0\ mT = 10^{-3}\ T$

$I = 1.0\ A$

$\mu_0 = 4\pi \cdot 10^{-7}\ N \cdot A^{-2}$

Solution:

The field for coil is $B = \dfrac{N\mu_0 I}{d}$ (a). Wire length $= N2\pi r = N\pi d$, $N = \dfrac{l}{\pi d}$.

Sub into (a) $= \dfrac{l\mu_0 I}{\pi d^2}$. Then $d^2 = \dfrac{l\mu_0 I}{B} \rightarrow d = \sqrt{\dfrac{l\mu_0 I}{B}}$.

$$d = \sqrt{\frac{1.0 \cdot 4\pi \cdot 10^{-7} \cdot 1.0}{10^{-3}}} = 0.035\ m$$

Answer: d = 0.035 m