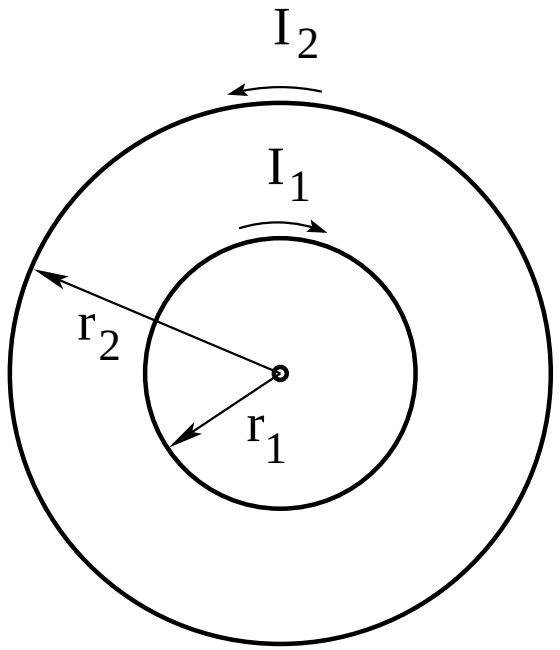
Unit Exam III: Problem #1 (Spring '08)

Consider two circular currents $I_1 = 3$A at radius $r_1 = 2$m and $I_2 = 5$A at radius $r_2 = 4$m in the directions shown.
(a) Find magnitude B and direction $(\odot, \otimes)$ of the resultant magnetic field at the center.
(b) Find magnitude μ and direction $(\odot, \otimes)$ of the magnetic dipole moment generated by the two currents.



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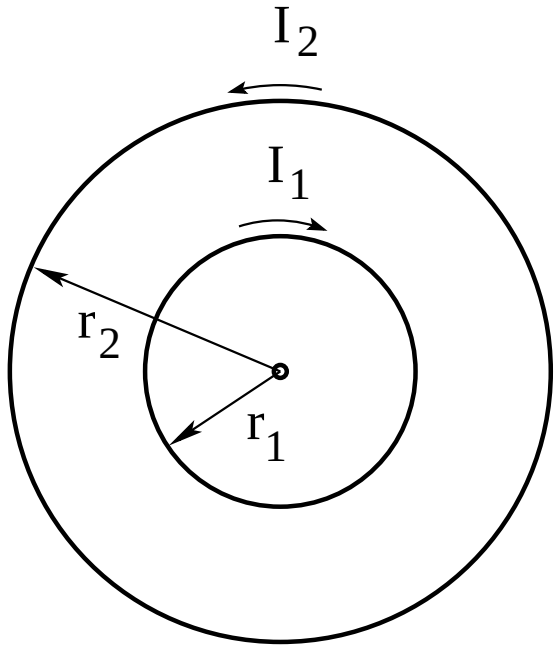
Solution:



(a) $B = \dfrac{\mu_0(3\text{A})}{2(2\text{m})} - \dfrac{\mu_0(5\text{A})}{2(4\text{m})} = (9.42 - 7.85) \times 10^{-7}\text{T}$

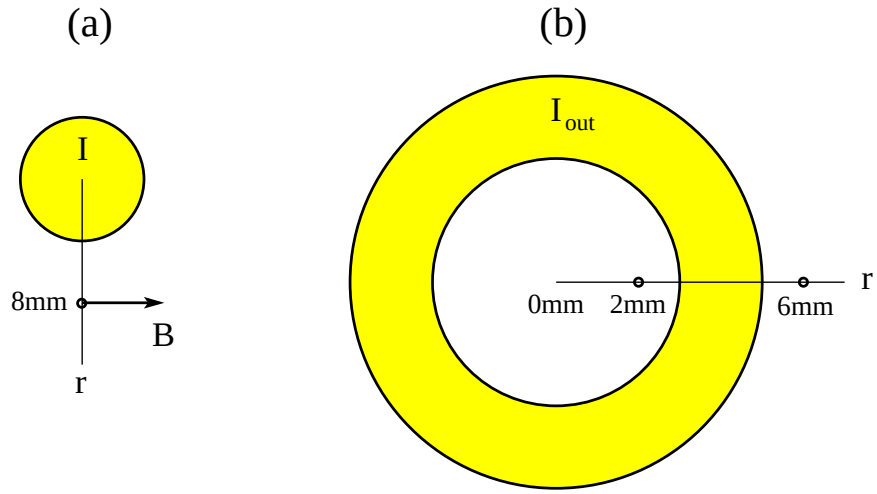
$\Rightarrow \; B = 1.57 \times 10^{-7}\text{T} \quad \otimes$

(b) $\mu = \pi(4\text{m})^2(5\text{A}) - \pi(2\text{m})^2(3\text{A}) = (251 - 38)\text{Am}^2$

$\Rightarrow \; \mu = 213\text{Am}^2 \quad \odot$

Unit Exam III: Problem #2 (Spring '08)

(a) Consider a solid wire of radius $R = 3$mm.
Find magnitude I and direction (in/out) that produces a magnetic field $B = 7\mu\mathrm{T}$ at radius $r = 8$mm.
(b) Consider a hollow cable with inner radius $R_{int} = 3$mm and outer radius $R_{ext} = 5$mm.
A current $I_{out} = 0.9$A is directed out of the plane.
Find direction (up/down) and magnitude B_2, B_6 of the magnetic field at radius $r_2 = 2$mm and $r_6 = 6$mm, respectively.



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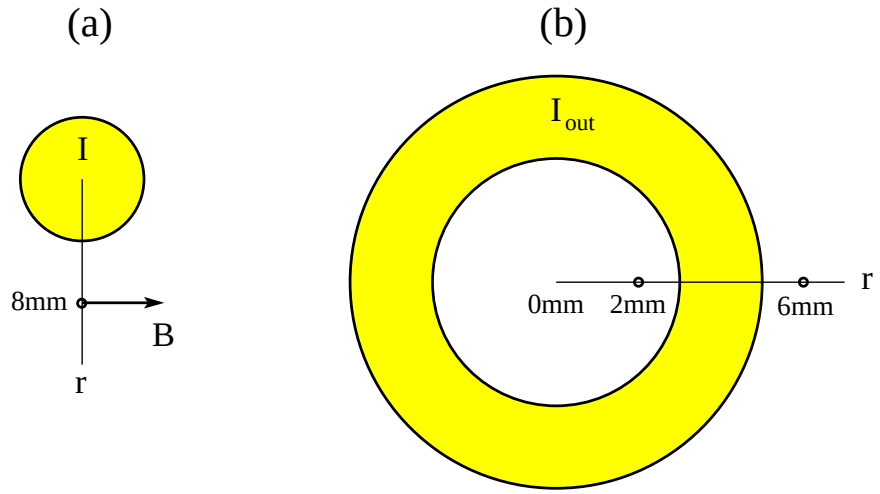
Solution:

(a) $7\mu\text{T} = \dfrac{\mu_0 I}{2\pi(8\text{mm})} \quad \Rightarrow \quad I = 0.28\text{A}$ (out).

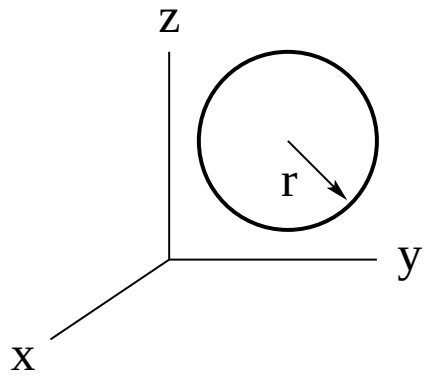
(b) $B_2 = 0, \qquad B_6 = \dfrac{\mu_0(0.9\text{A})}{2\pi(6\text{mm})} = 30\mu\text{T}$ (up).

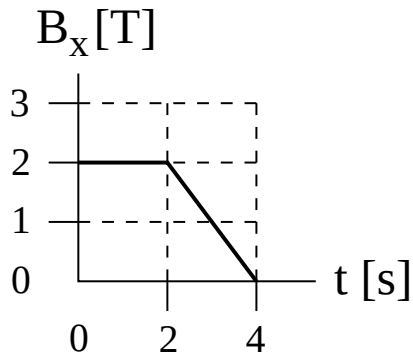


Unit Exam III: Problem #3 (Spring '08)

A circular wire of radius $r = 2.5$m and resistance $R = 4.8\Omega$ is placed in the yz-plane as shown.
A time-dependent magnetic field $\mathbf{B} = B_x\hat{\mathbf{i}}$ is present.
The dependence of B_x on time is shown graphically.

(a) Find the magnitude $|\Phi_B^{(1)}|$ and $|\Phi_B^{(3)}|$ of the magnetic flux through the cicle at times $t = 1$s and $t = 3$s, respectively.
(b) Find magnitude I_1, I_3 and direction (cw/ccw) of the induced current at times $t = 1$s and $t = 3$s, respectively.





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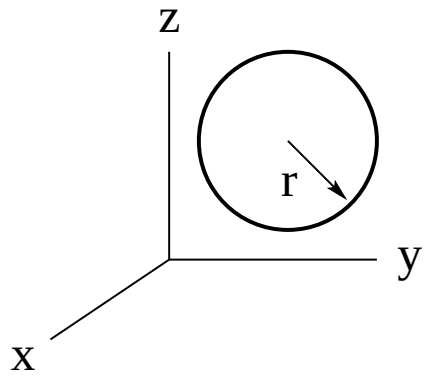

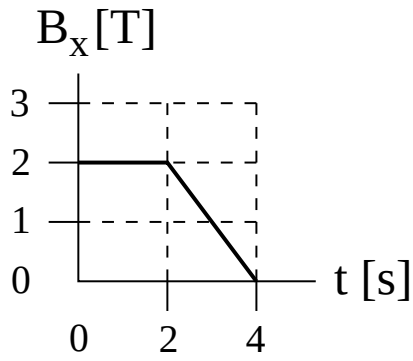

Solution:

(a) $|\Phi_B^{(1)}| = \pi(2.5\text{m})^2(2\text{T}) = 39.3\,\text{Wb},$

$|\Phi_B^{(3)}| = \pi(2.5\text{m})^2(1\text{T}) = 19.6\,\text{Wb}.$

(b) $\left|\dfrac{d\Phi_B^{(1)}}{dt}\right| = 0 \quad \Rightarrow \; I_1 = 0,$

$\left|\dfrac{d\Phi_B^{(3)}}{dt}\right| = |\pi(2.5\text{m})^2(-1\text{T/s})| = 19.6\text{V} \qquad \Rightarrow \; I_3 = \dfrac{19.6\text{V}}{4.8\Omega} = 4.1\text{A} \quad \text{(ccw)}.$