PHYS 102: General Physics 2 KOÇ UNIVERSITY Spring Semester 2015

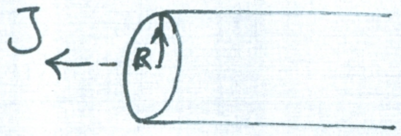
College of Sciences

Section 4 Quiz 8 30 April 2015

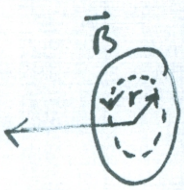
Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Consider a solid cylinder of radius R = 0.25 m that carries a current of 3 A where the current per unit area (current density J) is constant. Use Ampere's law to calculate the magnetic field of the cylinder at radius r = 0.125 m.



$R = 0.25\,m$



Ampere's law $\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{enc}$

$$I_{encl} = \int J \cdot dA = J A = J \pi r^2$$

$$J = \frac{I_{tot}}{\pi R^2} \Rightarrow I_{enc} = I_{tot} \left(\frac{r}{R}\right)^2$$

$\vec{B}$ is parallel to $d\vec{l}$ $\Rightarrow B(2\pi r) = \mu_0 I_{enc}$

$$\Rightarrow |\vec{B}| = \frac{\mu_0 I_{tot}}{2\pi} \frac{r}{R^2}$$

$$\Rightarrow |\vec{B}| = \frac{4\pi \times 10^{-7} \times 3 \times 125 \times 10^{-3}}{2\pi \times 25 \times 25 \times 10^{-4}} = 1.6 \times 10^{-6}\,T$$

PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2015**

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Section 5 **Quiz 8** **30 April 2015**

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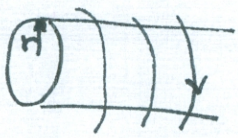
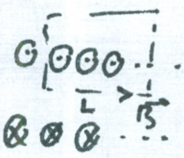
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Using Ampere's law, calculate the magnetic field B of a solenoid of length L = 2 cm with N = 20 turns, carrying a current of I = 3 A. (You may take $\pi = 3$.)





Ampere's law $\oint \vec{B}\cdot d\vec{l} = \mu_0 I$

$|\vec{B}| L = \mu_0 N I$

$\Rightarrow |\vec{B}| = \mu_0 n I$ where $n = \frac{N}{L}$

$n = \frac{20}{2\times 10^{-2}} = 10^{3} \frac{\text{turns}}{\text{Length}}$

$\mu_0 = 4\pi\times 10^{-7}$

$\Rightarrow |\vec{B}| = 4\pi\times 10^{-7}\times 10^{3}\times 3 \simeq 36\times 10^{-4}\, T$

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Section 3 **Quiz 8** **30 April 2015**

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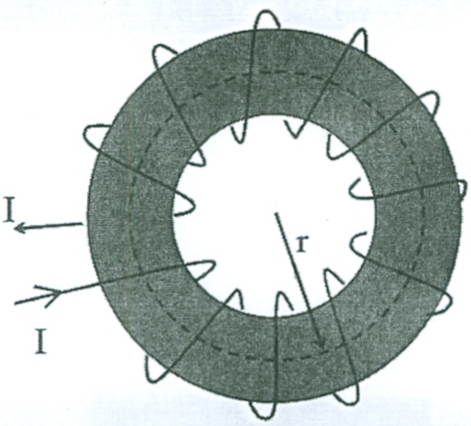
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Consider a toroidal solenoid with radius r = 0.25 m , N = 100 turns and carrying a current of I = 3 A. Using Ampere's law, calculate the magnetic field inside the toroidal solenoid.



Ampers law $\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{enc}$

$I_{enc} = NI$

$\Rightarrow B(2\pi r) = \mu_0 N I \Rightarrow B = \frac{\mu_0 N I}{2\pi r}$

$\Rightarrow B = \frac{4\pi \times 10^{-7} \times 100 \times 3}{2 \times \pi \times 25 \times 10^{-2}} = 24 \times 10^{-5}\ T$

$\vec{B}$ is counter clockwise

PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2015**

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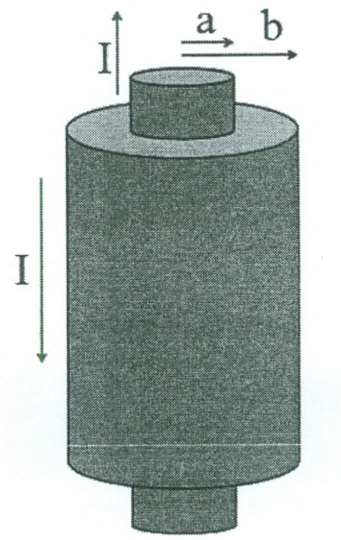
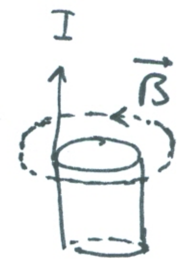
Section 1 **Quiz 8** **30 April 2015**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Equal and opposite currents I = 3 A are carried on the surfaces of long concentric thin cylinders of radii a = 0.25 m and b = 0.5 m, as shown in the sketch. Calculate the magnetic field as a function of radius r for (i) r < a, (ii) a < r < b, and (iii) r > b.





Amperes law: $\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{enc}$

$\vec{B}$ is parallel to $d\vec{l}$ $= \oint \vec{B}\cdot d\vec{l} = BL = 2\pi r B$

$\Rightarrow B = \frac{\mu_0 I_{enc}}{2\pi r}$

$$I_{enc} = \begin{cases} 0 & r < a \\ I & a < r < b \\ 0 & r > b \end{cases}$$

$\Rightarrow \vec{B} = 0$ for $r < a$, $|\vec{B}| = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 3}{2 \times \pi \times r} = \frac{6 \times 10^{-7}}{r}$ T

$\vec{B} = 0$ for $r > b$

PHYS 102: General Physics 2 KOÇ UNIVERSITY Spring Semester 2015

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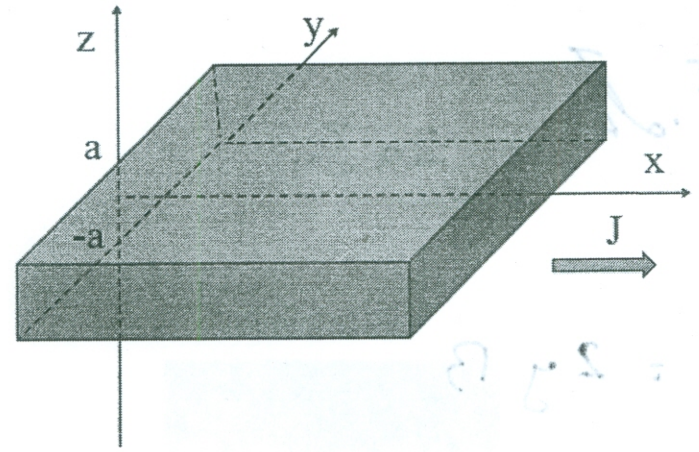
Section 2 Quiz 8 30 April 2015

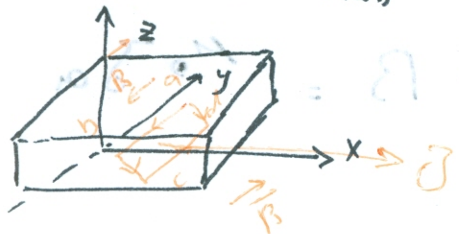
Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Consider an infinite slab parallel to the xy plane, extending from z = -a to z = +a, and carrying a current density J in the +x direction as shown in the sketch. What is the magnetic field both inside and outside the slab?



Inside the slab



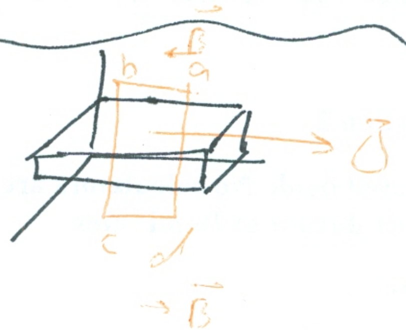
The z-component of magnetic field is zero because the slab is infinity in y-direction

Ampere's law $\oint_{abcd} \vec{B}\cdot d\vec{l} = \mu_0 I_{enc}$

$I_{enc} = \int J\, dA = Jy(2z) = 2Jyz$

$\oint_{abcd} \vec{B}\cdot d\vec{l} = \int_{ab} B\,dy + \int_{bc} 0 + \int_{cd} B\,dy + \int_{da} 0 = 2By$

$$\Rightarrow 2By = \mu_0 J \, 2yz \Rightarrow B = \mu_0 J z$$



For outside

Ampere's law $\oint_{abcd} \vec{B} \cdot d\vec{l} = \mu_0 I_{enc}$

$$I_{enc} = \int \vec{J} \cdot d\vec{A} = 2aJy$$

$$\oint_{abcd} \vec{B} \cdot dl = 2yB$$

$$\Rightarrow 2yB = \mu_0 2aJy \Rightarrow B = \mu_0 J a$$