PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2010**

College of Sciences

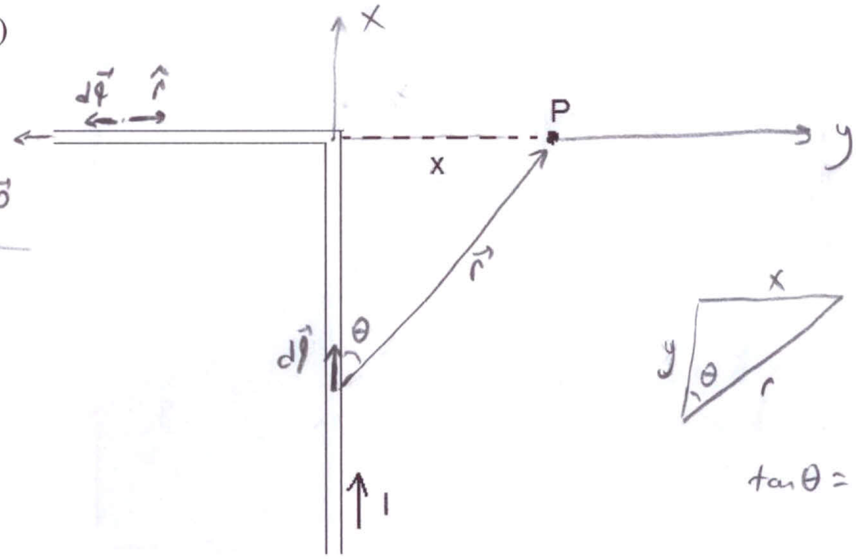
Section 1 **Quiz 8** **29 April 2010**

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

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

The wire shown in the figure is infinitely long and carries a current I. Starting from the Biot-Savart law,find the magnetic field (both magnitude and direction) at point P.

$(d\vec{B} = \frac{\mu_0}{4\pi}\frac{I\, d\vec{l} \times \hat{r}}{r^2})$



$d\vec{B} = 0$
for horizontal part, so $\vec{B} = \vec{0}$

for vertical part

$d\vec{B} = \frac{\mu_0 I}{4\pi}\frac{d\vec{l} \times \hat{r}}{r^2}$

$d\vec{B} = \hat{k}\,\frac{\mu_0 I}{4\pi}\frac{dl \sin\theta}{r^2}$

$\vec{B} = \hat{k}\int dB = \hat{k}\,\frac{\mu_0 I}{4\pi}\int\frac{dl \sin\theta}{r^2} = \hat{k}\,\frac{\mu_0 I}{4\pi}\int\frac{\sin\theta\, dy}{r^2}$

$\frac{\mu_0 I}{4\pi}\int_{\pi/2}^{0}\sin\theta \cdot \frac{\sin^2\theta}{x^2}\cdot\frac{(-x)\,d\theta}{\sin^2\theta}$

$= \frac{\mu_0 I}{4\pi}\int_0^{\pi/2}\frac{\sin\theta}{x}\,d\theta = \frac{\mu_0 I}{4\pi x}\cdot\Big[-\cos\theta\Big]_0^{\pi/2}$

$\vec{B} = \hat{k}\,\frac{\mu_0 I}{4\pi x}$

$\sin\theta = \frac{x}{r}$

$\tan\theta = \frac{x}{y}$

$\frac{1}{r^2} = \frac{\sin^2\theta}{x^2}$

$y = \frac{x}{\tan\theta}$

$\frac{dy}{dy} = \frac{d}{dy}\left(\frac{x}{\tan\theta}\right) = 1$

$x\,\frac{d}{dy}\left(\frac{\cos\theta}{\sin\theta}\right) = x\cdot\frac{(-\sin^2\theta - \cos^2\theta)}{\sin^2\theta}\cdot\frac{d\theta}{dy} = 1$

chain rule

$-\frac{x\,d\theta}{\sin^2\theta} = dy$

PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2010**

College of Sciences

Section 2 **Quiz 8** **29 April 2010**

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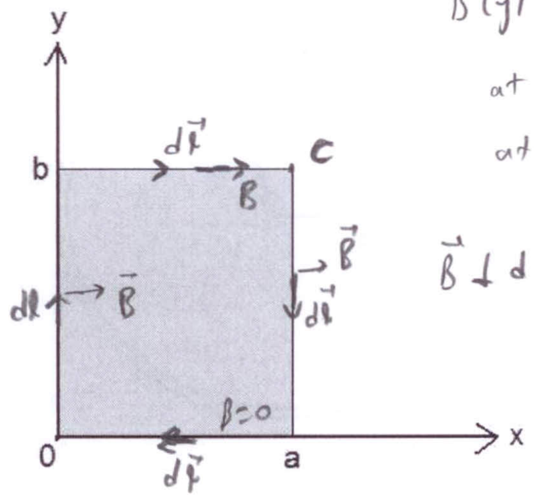
Quiz duration: 10 minutes

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

Using Ampere's law, find the direction and magnitude of the net current passing from the rectangular region shown in the figure, if the resulting magnetic field is $\vec{B} = Ay\,\hat{i}$, where A > 0 is a constant. ($\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{encl}$)



$\vec{B}(y) = Ay\hat{i}$

at $y=0$ $\vec{B}(0) = A0\hat{i} = 0$

at $y=b$ $\vec{B}(b) = Ab\hat{i}$

$\vec{B} \perp d\vec{l}$ means $\vec{B}$ and $d\vec{l}$ are perpendicular so dot product give us zero.

$$\oint \vec{B}\cdot d\vec{l} = \underbrace{\int_0^b \vec{B}\cdot d\vec{l}}_{\vec{B}\perp d\vec{l}} + \int_b^c \vec{B}\cdot d\vec{l} + \underbrace{\int_c^a \vec{B}\cdot d\vec{l}}_{\vec{B}\perp d\vec{l}} + \underbrace{\int_a^0 \vec{B}\cdot d\vec{l}}_{0} = 0 + \int_b^c \vec{B}\cdot d\vec{l} + 0 + 0$$

$$\oint \vec{B}\cdot d\vec{l} = \int_b^c \vec{B}\cdot d\vec{l} = \int_b^c (A.b.\hat{i}).(dx\,\hat{i}) = Ab\underbrace{\int_b^c dx}_{\text{length of } bc} = Aba = \mu_0 I_{enc}$$

$I_{enc} = \dfrac{Aba}{\mu_0}$ (direction is in to the page, $-\hat{k}$, from right hand rule)
look at $d\vec{l}$

PHYS 102: General Physics 2 KOÇ UNIVERSITY Spring Semester 2010

College of Sciences

Section 3 Quiz 8 29 April 2010

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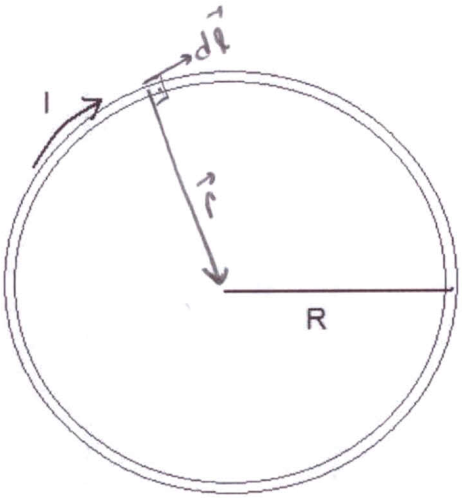
Quiz duration: 10 minutes

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

A circular loop has radius R and carries a current I in a clockwise direction. Starting from the Biot –Savart law, find the magnetic field (both magnitude and direction) at its center.

($d\vec{B} = \frac{\mu_0}{4\pi}\frac{I\, d\vec{l} \times \hat{r}}{r^2}$)

from right hand rule direction is in to the page.



$d\vec{l}$ and $\vec{r}$ are perpendicular to each other.

$$d\vec{B} = \frac{\mu_0}{4\pi} I \frac{d\vec{l} \times \hat{r}}{r^2}$$

$$dB = \frac{\mu_0}{4\pi} I \frac{dl}{r^2} = \frac{\mu_0 I}{4\pi}\frac{R\, d\theta}{R^2}$$

$$B = \int dB = \frac{\mu_0 I}{4\pi}\int_0^{2\pi}\frac{d\theta}{R} = \frac{\mu_0 I}{4\pi R} 2\pi = \frac{\mu_0 I}{2R}$$

PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2010**

College of Sciences

Section 4 **Quiz 8** **29 April 2010**

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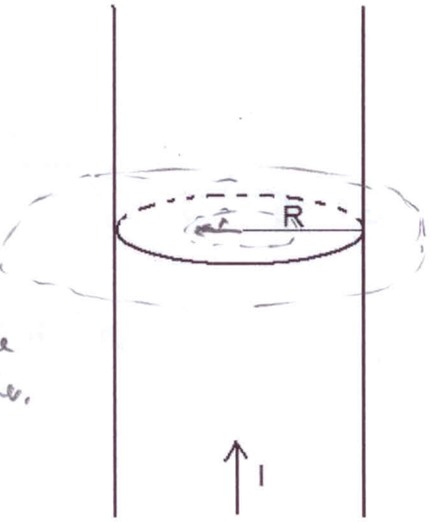
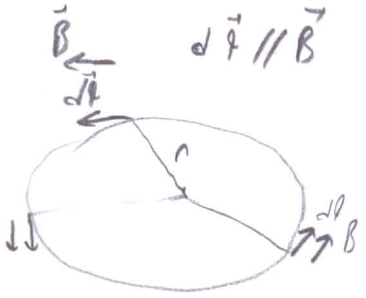
Quiz duration: 10 minutes

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

A cylindrical wire with radius R carries a current I. The current is uniformly distributed over the cross-sectional area of the conductor. Using Ampere's law, find the magnetic field (both magnitude and direction) everywhere (for r < R and r > R), ($\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{encl}$).

draw a circle which has the same (axis) center as the cylinder has.
by using symmetry argument
i.e. any two point on this circle cannot be distinguished from other.





$d\vec{\ell}\cdot\vec{B} = B\,d\ell$

$$\oint \vec{B}\cdot d\vec{\ell} = \int B\,d\ell = B\int d\ell = B\,2\pi r = \mu_0 I_{enc}$$

for $r \leq R$ $\quad I_{enc} = \pi r^2 \cdot \dfrac{I}{\pi R^2} = I\dfrac{r^2}{R^2} \qquad B = \dfrac{\mu_0 I_{enc}}{2\pi r} = \dfrac{\mu_0 I r^2}{2\pi r R^2} = \dfrac{\mu_0 I r}{2\pi R^2}$

for $r \geq R$ $\quad I_{enc} = I \qquad B = \dfrac{\mu_0 I_{enc}}{2\pi r} = \dfrac{\mu_0 I}{2\pi r}$

PHYS 102: General Physics 2 **KOÇ UNIVERSITY** **Spring Semester 2010**

College of Sciences

Section 5 **Quiz 8** **29 April 2010**

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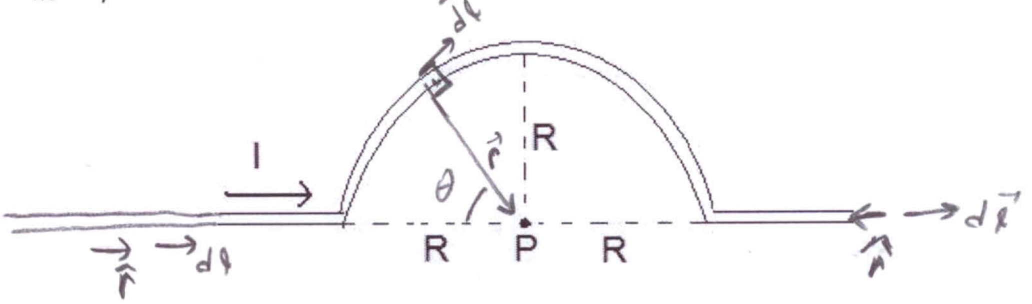
Quiz duration: 10 minutes

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

The wire shown in the figure is infinitely long and carries a current I. Starting from the Biot-Savart law, find the magnetic field (both magnitude and direction) at point P.

$(d\vec{B} = \frac{\mu_0}{4\pi}\frac{I\, d\vec{l} \times \hat{r}}{r^2})$



for the straight part $d\vec{l} \times \hat{r} = \vec{0}$ since $\sin(0) = \sin(\pi) = 0$

for curvature

$$dB = \frac{\mu_0}{4\pi}\frac{I\, dl . |\hat{r}| . \sin(\pi/2)}{r^2} = \frac{\mu_0 I}{4\pi}\frac{dl}{r^2}$$

$dl = R . d\theta$

$r = R$

$$B = \int dB = \frac{\mu_0 I}{4\pi}\int\frac{R\, d\theta}{R^2} = \frac{\mu_0 I}{4\pi R}\int_0^{\pi} d\theta = \frac{\mu_0 I}{4R} \otimes$$

direction is in-to-the page, from righ hand rule