LEY DE BIOT - SAVART

VECTORIAL:

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

$\mu_0 = 4\pi \cdot 10^{-7} \frac{T \cdot m}{A}$

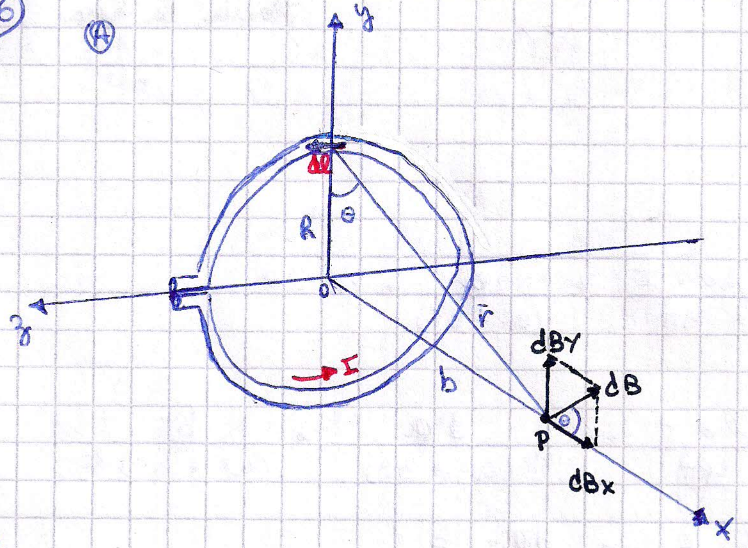
MÓDULO:

$$dB = \frac{\mu_0}{4\pi} \frac{I\, dl}{r^2} \cdot \operatorname{sen}\theta$$

- θ es el ángulo entre dl y r

(166)

(A)



(B)

$d\bar{l}$ y $\bar{r}$ son perpendiculares $\Rightarrow \operatorname{sen} 90° = 1$

$$dB = \frac{\mu_0}{4\pi} \cdot \frac{I \cdot dl}{r^2}$$

$$r^2 = b^2 + R^2$$

$$r = (b^2 + R^2)^{1/2}$$

$$dB = \frac{\mu_0}{4\pi} \cdot \frac{I\, dl}{(b^2 + R^2)}$$

Por simetría, $dB_y = 0 \Rightarrow$ solo tenemos $dB_x = dB \cdot \cos\theta$

$$\cos\theta = \frac{R}{(b^2 + R^2)^{1/2}} \Rightarrow dB_x = \frac{\mu_0 \cdot I}{4\pi} \cdot \frac{dl}{(b^2+R^2)} \cdot \frac{R}{(b^2+R^2)^{1/2}}$$

$$dB_x = \frac{\mu_0 \cdot I}{4\pi} \cdot \frac{dl}{(b^2+R^2)^{3/2}} \cdot R$$

$$dl = R \cdot d\theta \Rightarrow dB_x = \frac{\mu_0 \cdot I}{4\pi} \cdot \frac{R^2\, d\theta}{(b^2+R^2)^{3/2}}$$

$$B = B_x = \int dB_x = \int \frac{\mu_0 \cdot I}{4\pi} \cdot \frac{R^2\, d\theta}{(b^2+R^2)^{3/2}} = \frac{\mu_0 \cdot I}{4\pi} \cdot \frac{R^2}{(b^2+R^2)^{3/2}} \int_0^{2\pi} d\theta$$

$$= \frac{\mu_0 I}{\cancel{4\pi}} \cdot \frac{R^2\, \cancel{2\pi}}{(b^2+R^2)^{3/2}} \Rightarrow \boxed{B = \frac{\mu_0 \cdot I}{2} \cdot \frac{R^2}{(b^2+R^2)^{3/2}}}$$

(c)

En el centro de la esfera $\Rightarrow$ $b = 0$

$$B = \frac{\mu_0 \cdot I}{2} \cdot \frac{R^2}{(0^2 + R^2)^{3/2}} \Rightarrow \boxed{B = \frac{\mu_0 \cdot I}{2R}}$$

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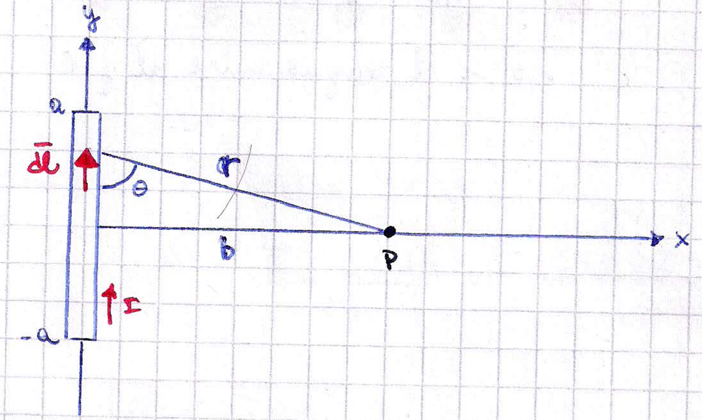

dB = ⊗
Hacia la hoja

$dl = da$

$$dB = \frac{\mu_0 \cdot I}{4\pi} \cdot \frac{da}{(a^2 + b^2)} \cdot \operatorname{sen}\theta$$

$$dB = \frac{\mu_0 \cdot I}{4\pi} \cdot \frac{da}{(a^2 + b^2)} \cdot \frac{b}{(a^2 + b^2)^{1/2}}$$

$$dB = \frac{\mu_0 \cdot I}{4\pi} \cdot \frac{da \cdot b}{(a^2 + b^2)^{3/2}}$$

$$B = \int dB = \frac{\mu_0 \cdot I}{4\pi} \cdot \int_{-a}^{a} \frac{b}{(a^2 + b^2)^{3/2}} \, da \Rightarrow \text{POR TABLA}$$

$$B = \frac{\mu_0 \cdot I}{4\pi} \cdot \frac{2a}{b \cdot \sqrt{b^2 + a^2}}$$

Como el conductor es infinito:

$$B = \lim_{a \to \infty} \frac{\mu_0 \cdot I}{4\pi} \cdot \frac{2a}{b \cdot \underbrace{\sqrt{b^2 + a^2}}_{\to a}}$$

$$\boxed{B = \frac{\mu_0 \cdot I}{2\pi b}}$$

NOTA

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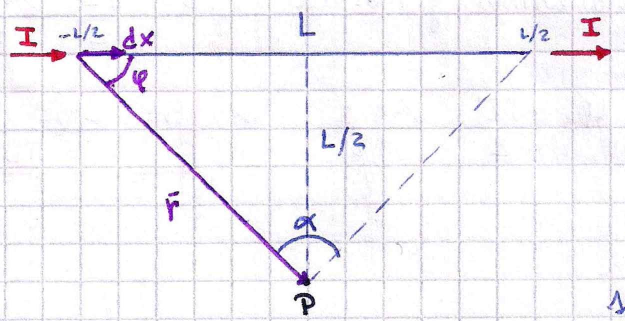

$$\alpha = 90^\circ$$

$$r^2 = x^2 + \frac{L^2}{4}$$

$$\operatorname{sen}\varphi = \frac{L/2}{\left(x^2 + \frac{L^2}{4}\right)^{1/2}}$$

$$dl = dx$$

$$dB = \frac{\mu_0 \cdot I}{4\pi} \cdot \frac{dx}{x^2 + \frac{L^2}{4}} \cdot \frac{L/2}{\left(x^2 + \frac{L^2}{4}\right)^{1/2}}$$

$$B = \int_{-L/2}^{L/2} dB = \frac{\mu_0 \cdot I}{4\pi} \cdot L/2 \int_{-L/2}^{L/2} \frac{dx}{\left(x^2 + \frac{L^2}{4}\right)^{3/2}} = \frac{\mu_0 I}{4\pi}\, L/2 \left. \frac{x}{\frac{L^2}{4}\left(x^2 + \frac{L^2}{4}\right)^{1/2}} \right|_{-L/2}^{L/2}$$

$$= \frac{\mu_0 I}{\cancel{4}\pi} \frac{\cancel{L}}{2} \frac{\cancel{4}}{L^{\cancel{2}}} \cdot \left[\frac{L/2}{\left(\frac{L^2}{4} + \frac{L^2}{4}\right)^{1/2}} - \frac{-L/2}{\left(\frac{L^2}{4} + \frac{L^2}{4}\right)^{1/2}} \right]$$

$$= \frac{\mu_0 \cdot I}{2\pi L} \cdot \left[\frac{L}{\left(\frac{L^2}{2}\right)^{1/2}} \right] = \frac{\mu_0 I}{2\pi L} \cdot \frac{\cancel{L}}{\frac{\cancel{L}}{\sqrt{2}}} = \frac{\mu_0 I}{2\pi L} \sqrt{2}$$

$$\boxed{B = \frac{\mu_0 \cdot I}{\pi L} \frac{\sqrt{2}}{2}}$$

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Para un solo alambre calculamos y nos dió: $B = \frac{\sqrt{2}}{2} \frac{\mu_0 \cdot I}{\pi L}$

Entonces para 4 será: $\cancel{4}^{2} \cdot \frac{\sqrt{2}}{\cancel{2}} \frac{\mu_0 I}{\pi L} \Rightarrow \boxed{B = \frac{2\sqrt{2}\, \mu_0 \cdot I}{\pi L}}$

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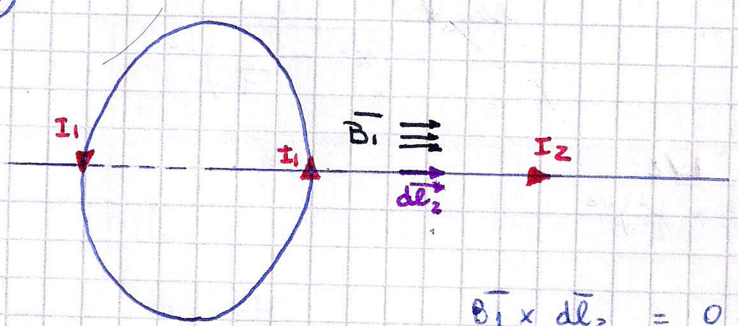

$\bar{B_1} \times d\bar{l_2} = 0$; son paralelos

$\boxed{F_{22} = 0}$

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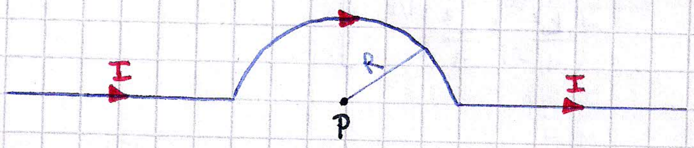

Regla de la mano derecha:
Campo en P entrante ⊗.

En el 162, el campo en el centro de la espira dió:

$$B = \frac{\mu_0 \cdot I}{2R}$$

Entonces para la mitad será $\frac{B}{2} \Rightarrow \boxed{B = \frac{\mu_0 \cdot I}{4R}}$

Los tramos rectos no contribuyen, ya que $\vec{dl}$ y $\vec{r}$ son paralelos.

NOTA

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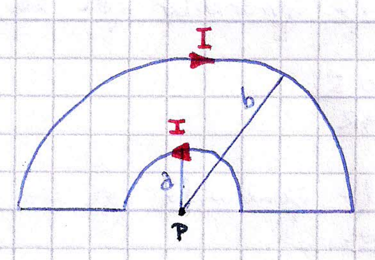

Regla de la mano derecha.
El campo según b en el centro será entrante $(-\check{k})$ y según a será saliente $(+\check{k})$.

$$\bar{B}_{Pb} = \frac{\mu_0 \cdot I}{4b}(-\check{k})$$

$$\bar{B}_{Pa} = \frac{\mu_0 \cdot I}{4a}(\check{k})$$

$$\Rightarrow \bar{B}_P = \bar{B}_{Pb} + \bar{B}_{Pa} = (\check{k}) \cdot \left(\frac{\mu_0 \cdot I}{4a} - \frac{\mu_0 \cdot I}{4b}\right)$$

$$\bar{B}_P = \frac{\mu_0 \cdot I}{4}\check{k}\left(\frac{1}{a} - \frac{1}{b}\right)$$

$$\boxed{B = \frac{\mu_0 \cdot I}{4}\,\frac{b-a}{a \cdot b}}$$ SALIENTE

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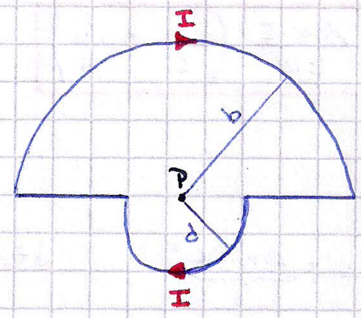


Regla de la mano derecha.

El campo según a y b será entrante $(-\check{k})$.

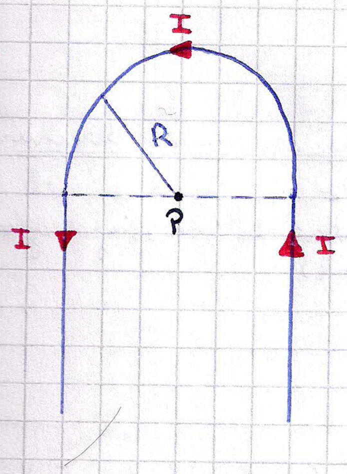
$$\bar{B}_{Pb} = \frac{\mu_0 \cdot I}{4b}(-\check{k})$$

$$\bar{B}_{Pa} = \frac{\mu_0 \cdot I}{4a}(-\check{k})$$

$$\Rightarrow \bar{B}_P = \bar{B}_{Pa} + \bar{B}_{Pb} = (-\check{k})\frac{\mu_0 \cdot I}{4}\left(\frac{1}{a} + \frac{1}{b}\right)$$

$$\boxed{B = \frac{\mu_0 \cdot I}{4} \cdot \frac{a+b}{b \cdot a}}$$ ENTRANTE

(174)



El campo generado por la semi:

$$B = \frac{\mu_0 I}{4R}$$

El campo generado por un conductor infinito:

$$B = \frac{\mu_0 \cdot I}{2\pi R}$$

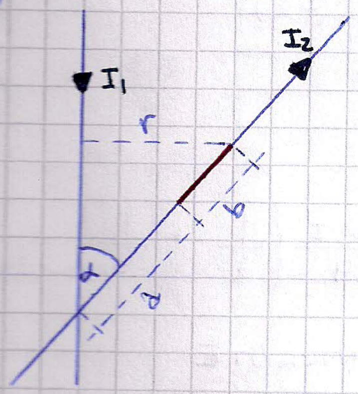
Como en el conductor contribuye infinitamente hacia abajo, podemos considerar solo la contribución de la mitad:

$$B = \frac{\mu_0 \cdot I}{4\pi R}$$

Entonces:

$$B_p = 2 \cdot \frac{\mu_0 \cdot I}{4\pi R} + \frac{\mu_0 I}{4R} \Rightarrow \boxed{B = \frac{\mu_0 \cdot I}{2R}\left(\frac{1}{2} + \frac{1}{\pi}\right)}$$

(175)



$$B_{21} = \frac{\mu_0 \cdot I_1}{2\pi r} \cdot \underbrace{\operatorname{sen} 90^\circ}_{=1}$$

$$dF_{21} = I_2 \cdot dl_2 \cdot B_{21}$$

$$dF_{21} = I_2 \cdot dl_2 \cdot \frac{\mu_0 I_1}{2\pi r}$$

$$B_{21} = \frac{\mu_0 \cdot I_1}{2\pi r}$$

$$\operatorname{sen} \alpha = \frac{r}{\partial b} \qquad \cdot\ \partial b = l_2$$

$$\operatorname{sen} \alpha = \frac{r}{l_2} \Rightarrow \operatorname{sen} \alpha \cdot l_2 = r$$

$$dr = \operatorname{sen} \alpha \cdot dl_2$$

$$dl_2 = \frac{dr}{\operatorname{sen} \alpha}$$

$$F_{21} = \int dF_{21} = \int \frac{\mu_0 I_1}{2\pi r} I_2\, dl_2 = \int_{r_1}^{r_2} \frac{\mu_0 I_1}{2\pi r} I_2 \cdot \frac{dr}{\operatorname{sen}\alpha} = \frac{\mu_0 \cdot I_1 I_2}{2\pi \operatorname{sen}\alpha} \int_a^{a+b} \frac{dr}{r}$$

$$\boxed{F_{21} = \frac{\mu_0 \cdot I_1 \cdot I_2}{2\pi \operatorname{sen}\alpha} \cdot \ln\left(\frac{a+b}{a}\right)}$$