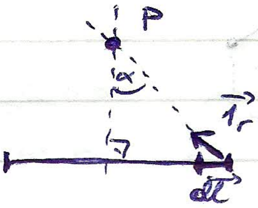
Ad. 4

BIOT-SAVART'S LAW

$$d\vec{B} = \frac{\mu_0}{4\pi} I \frac{d\vec{l} \times \vec{1_r}}{r^2}$$

First we derive a helpful formula



$d\vec{l} \times \vec{1_r} = dl \cdot \sin(90 - \alpha) =$

$= dl \cos\alpha$

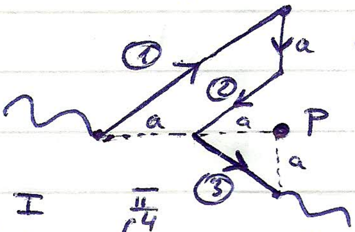
$\cos\alpha = \frac{R}{r} \Rightarrow \frac{\cos^2\alpha}{R^2} = \frac{1}{r^2}$

$$dB = \frac{\mu_0}{4\pi} I \frac{dl \cos^2\alpha}{R^2}$$

$$\frac{l}{R} = tg\,\alpha \Rightarrow dl = \frac{R}{\cos^2\alpha} d\alpha$$

$$dB = \frac{\mu_0}{4\pi} I \frac{\cos\alpha}{R} d\alpha$$

$$B = \frac{\mu_0 I}{4\pi R} \int_{\alpha_{min}}^{\alpha_{max}} \cos\alpha \, d\alpha \qquad \alpha_{min}, \alpha_{max} \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$$



← no contribution to magnetic field intensity

$$B_{1} = \frac{\mu_0 I}{4\pi a\sqrt{2}} \cdot \int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \cos\alpha \, d\alpha \qquad \text{direction: } \otimes$$

$$B_{2} = \frac{\mu_0 I}{4\pi\left(\frac{a\sqrt{2}}{2}\right)} \cdot \int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \cos\alpha \, d\alpha \qquad \text{direction: } \odot$$

$$B_{3} = \frac{\mu_0 I}{4\pi\left(\frac{a\sqrt{2}}{2}\right)} \cdot \int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \cos\alpha \, d\alpha \qquad \text{direction: } \odot$$

$$B = B_{1} - B_{2} - B_{3} = B_{1} - 2 \cdot B_{1} - 2 B_{1} = -3 B_{1}$$

$$B_{1} = \frac{\mu_0 I}{4\pi a\sqrt{2}} \cdot \int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \cos\alpha \, d\alpha = \frac{\mu_0 I}{4\pi a\sqrt{2}} \sin\alpha \Big|_{-\frac{\pi}{4}}^{\frac{\pi}{4}} = \frac{\mu_0 I}{4\pi a} =$$

$$= 10^{-7} \cdot \frac{10}{0.1} = 10^{-5} \text{ T}$$

$$B = -3 \cdot 10^{-5} \text{ T} \Rightarrow H = -3 \cdot 10^{-5} \cdot \frac{10^7}{4\pi} \approx -23.87$$

the sign means $\odot$